

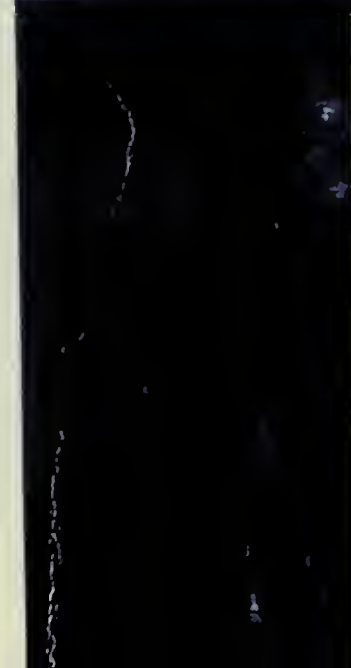


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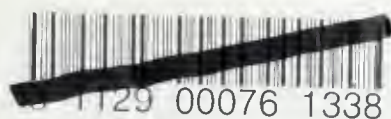


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"The valuable features of Illinois coal are that there is plenty of it, that it is widely distributed over the State... and, poor as the coal is, there is a large market for it, for want of better".

-James MacFarlane
Coal Regions of America, 1877



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ACKNOWLEDGMENTS

IBM acknowledges the help of many agencies and individuals without whose assistance and guidance this study could not have been possible. The results and conclusions are, however, the sole responsibility of IBM.

Thanks are especially due to Mr. Jack A. Simon, Principal Geologist of the Illinois Geological Survey, for his cooperation, advice and patience which contributed in large measure to the study's success. The general encouragement and counsel of Mr. John S. Moore, Illinois Department of Public Health, and members of the Advisory Board are also appreciated. The Advisory Board is composed of contained state, industrial and labor representation including: J. Karl Aldrich, Jack A. Simon, Otis J. Gibson, George J. Gockstetter, Paul B. Hodges, Harold L. Rice, Kenneth Wells and L. Leon Ruff. Messrs. Robert Jameson and Russell Flegal, HEW, provided useful assistance and advice.

C. W. Klassen, Director of the Illinois Environmental Protection Agency, and Franklin D. Yoder, Director of the Illinois Department of Public Health, as well as Robert R. French, Chief of the Illinois Bureau of Air Pollution Control, provided necessary support and advice for this study.

Mr. Otis Gibson, Mr. Frank Sarno and Mr. James Mullins of the Midwest Coal Producers' Institute, Inc., facilitated producer liaison in response to requests by the study team. Thanks are also due to the many coal companies who cooperated by supplying basic information.

Gratitude is expressed to the Indiana, Illinois and Kentucky Geological Surveys for placing facilities and personnel at our disposal. Dr. M. E. Hopkins and H. E. Risser of Illinois Geological Survey provided valuable assistance. Dr. Charles Wier of the Indiana Geological Survey and Mr. Gilbert Smith of the Kentucky Geological Survey, gave considerable time and advice to the study team. Mr. S. J. Aresco, U. S. Bureau of Mines, in cooperation with HEW, supplied useful basic coal quality data.

IBM is indebted to Mr. Clark Grover and other members of the Fuels Planning Branch, Tennessee Valley Authority for advice concerning the coal reserves of western Kentucky of reports. Mr. A. T. Mullins and Mr. N. Allen of the TVA Fuels Planning Staff assisted in locating mines by quadrangle over the west Kentucky coal field.

This study was intended as an independent investigation of low sulfur coal reserves in Illinois, Indiana, and west Kentucky. While the assistance of State and Federal officials is gratefully acknowledged, this in no way suggests their complete agreement with the data, methodology or results.

Assistance in data collection was provided by: Connie Armstrong, Barbara Mitchell, and Peter Tarkoy in Illinois; Rick Donica, Bonnie Figg and Alan Keiser in Indiana; and Dr. Richard Bergenback, James Easen, Sherm Spencer and Dorothy Ventress at TVA offices, Chattanooga, Tennessee.

FORWORD

The Illinois Coal Study was first conceived early in 1967 and at that time the Study was envisioned to establish the facts about coal production and reserves in the Midwest and from these facts make an economic evaluation of the impact of limiting the use of high sulfur coal. One of the motivations leading to the Illinois Coal Study was a lack of information concerning the true nature of the coal reserves by many persons in governmental and planning positions. Far reaching strategies concerning the limitation of the use of high sulfur coal were being developed by a number of governmental bodies without benefit of all of the facts. Since these strategies limiting the use of coal impacted on other groups who were forming similar plans, the need for this study was apparent.

When it became quite clear that a comprehensive study was needed to bring together many of the valuable sources of information which had been diligently collected by various agencies but often not used by rule forming bodies, interest was generated by a number of people and agencies to begin the task.

It was learned that there were federal funds available for studies of this nature and inquiries were made to the U. S. Department of Health, Education, and Welfare where favorable response was received. It appeared that the State of Illinois would be eligible for three to one matching funds to conduct such a study and the Illinois Air Pollution Control Board attempted to find the necessary \$50,000 matching fund to acquire federal financial support. State money had previously not been budgeted for a study of this magnitude and it became apparent that the State was in danger of not receiving the federal grant. The Mid-West Coal Producers' Institute, learning of the State's plight, volunteered to donate the necessary matching money to the State, no strings attached. After long deliberation, the Illinois Air Pollution Control Board and the Illinois Department of Public Health decided to accept the offer of the Mid-West Coal Producers' Institute and the Study became viable again. Negotiations with the federal government continued and several preliminary study plans were prepared.

At that time, the plan was to conduct the Study "in shop" by acquiring a full-time Project Administrator and two research assistants to work along with the staff of the State Bureau of Air Pollution Control in the conduct of this study. It became apparent, however, that considerably more man-hours would be necessary to complete this important study in such a short period of time. The only other alternative was to have the Study done on contract. After assessing the qualifications of several different groups interested in performing this study, it was determined that the Federal Systems Division of IBM Corporation could best serve the needs of all parties involved, particularly since they had had past experience with the air pollution agency and were then conducting the Total Health Information Study for the Illinois Department of Public Health.

A contract was signed in March of 1969 and the work began on the first of the three phases of the Study.

The first phase was the study of the feasibility of a state-wide emission inventory of all air pollution sources which turned out to be exceedingly valuable as a strategy tool in the many considerations necessary in any decision impacting upon the use of low sulfur coal as an air pollution control method. This first phase is not included in the published material contained herein. The second phase of the Study begins with the published material contained in this report and is a study of all of the resources of low sulfur coal in the Mid-West coal basin which includes Illinois, Western Indiana and Western Kentucky. The material generated by this phase

makes up the bulk of the printed material contained in the Study. Phase III is an assessment of the economic factors involved in limiting the use of high sulfur coal and, naturally, is the most subjective part of the Study.

Considering the tremendous task and the very short period of time involved, certain techniques were applied which might be open to criticism. However, in order to complete the Study in the time frame necessary, particularly with the number of important environmental decisions to be made, it was decided to use certain rapid survey techniques described in the text.

It is my hope that this Study will be the beginning of even more deliberate work into the logical and economical use of our resources and most importantly the environmental impact of our stewardship of our resources.

John S. Moore
Project Administrator

SECTION 1

1.1 INTRODUCTION

In the previous study prepared by IBM for the State of Illinois Department of Public Health, *Air Quality Monitoring System in Support of the Total Health Information System (THIS) Study*, real-time control measures were discussed. In that study the analogy between the production of air pollution and other processes was drawn and it was suggested that process control analysis was applicable to air pollution control problems. In Figure 1-1 a schematic of the interrelationships among the components of the air pollution process is provided. Identified are the classical inputs, (weather and pollutants) outputs, (emissions resulting in a certain air quality) means of measurement, (the aerometric system) and means of control (various control options).

The real-time measures discussed in the previous study were based on control tactics designed to provide reaction to changes in controlling weather conditions -- by limiting pollutant emission. These are short-term control approaches, for it becomes apparent that in the short-term the emission sources are constant, and the controlling weather variant, while in the long-term, a general climatological pattern is characteristic of a region, but new pollution sources add increased emissions to the system.

In this study, long-term control measures will be considered. Long-term control can take many forms. Most of the strategic control options are formalized by local ordinances and state codes and are directed toward a permanent diminution of the pollutants in the system, rather than reaction to temporary, weather-induced rises in the pollution levels.

A major pollutant in metropolitan and industrial areas is SO_2 , a substance generated in the combustion of sulfur-bearing fuels. For most industrial applications, in the mid-western U. S., coal is used. Consequently, the possibility of utilizing coals of reduced sulfur content is often suggested as a pollution control strategy in industrial areas. This study seeks to determine the magnitude of low-sulfur coal available for such pollution control, and the economic implications of prohibitions upon the use of high sulfur coal.

1.2 STUDY ACTIVITIES

The IBM study comprised the following activities:

- a. Formulation of a methodology for developing an emission inventory of the major pollution sources in the state.
- b. A determination of the location and extent of low sulfur coal reserves within the Illinois Basin.
- c. An assessment of the anticipated impact of prohibitions on use of high sulfur coals, as a means of limiting air pollution upon the states and industries of the Illinois Basin.

1.3 STUDY ORGANIZATION

This study was conducted within the Federal Systems Center of the IBM Federal Systems Division in Gaithersburg, Maryland. The study team was com-

posed of IBM scientists and analysts assigned to this project.

The study was directed by Dr. Fred F. Gorschboth, Manager of Natural Resource Systems Department, with a team composed of Dr. G. S. Butterworth, Mrs. G. Coker, Mr. C. M. Fu, and Mr. B. B. Clark. Dr. F. J. Wobber, previously of the IBM Corporation, continued in a primary consulting role throughout the study.

SECTION 2

2.1 PROBLEM

Coal resources constitute the largest national energy reserve and are found in 34 of the 50 states. Recoverable reserves --- which vary with quality, depth, and local economic factors --- are estimated by Bureau of Mines at nearly 800 billion tons.

Areas of principal consumption include the major coal producing states of Illinois, Indiana, and Kentucky. The electric utility market constitutes one of the most important users of coal and accounts for over 60% of total coal consumption. In addition, the steel industry uses large quantities of low sulfur coal in the steel-making process. While the outlook for increased coal consumption is bright, restrictions against sulfur oxides and other combustion products pose a substantial threat to the coal industry in its traditional market areas.

Some degree of pollution control in metropolitan areas may be achieved by requiring large users to shift from high-sulfur to low-sulfur fuels permanently or during occasional periods of serious air stagnation. Interest in this approach has heightened with the realization that additional time might be required to make available economical and effective stack emission suppression equipment.

Basic control approach to reduce the amount of sulfur oxides in industrial effluents include (1) use of natural low sulfur coals, (2) removal of the majority of sulfur compounds at the mine using coal-cleaning methods, and (3) alternate production facilities or methods, e.g. hydrogenation and gasification of coal, (4) emission suppression at the stacks.

There is, however, no assurance that low sulfur coal supplies, particularly in the Midwest Coal Field (MWCF), are adequate to supply the demands of industry, especially when low sulfur coal commands a premium price in the coke and steel industry.

Aside from increased price, which many suggest is an essential prerequisite for making low sulfur coal available for industry and especially the electric utility market, more information is required concerning the quantity of low sulfur coal reserves actually existent. A variety of geological questions related to low sulfur reserves must be answered --- including quantity, geographic distribution, thickness of deposit and thickness of overburden. Reserves dedicated to certain industries under long-term contracts, for example the steel industry, must also be considered. Even if it is assumed that natural low-sulfur coal supplies are available, still other problems are of concern, including facilities modification requirements to burn low sulfur coals, (e.g., the ash slugging properties of some low sulfur coals may not be suitable for combustion equipment designed for higher sulfur fuels).

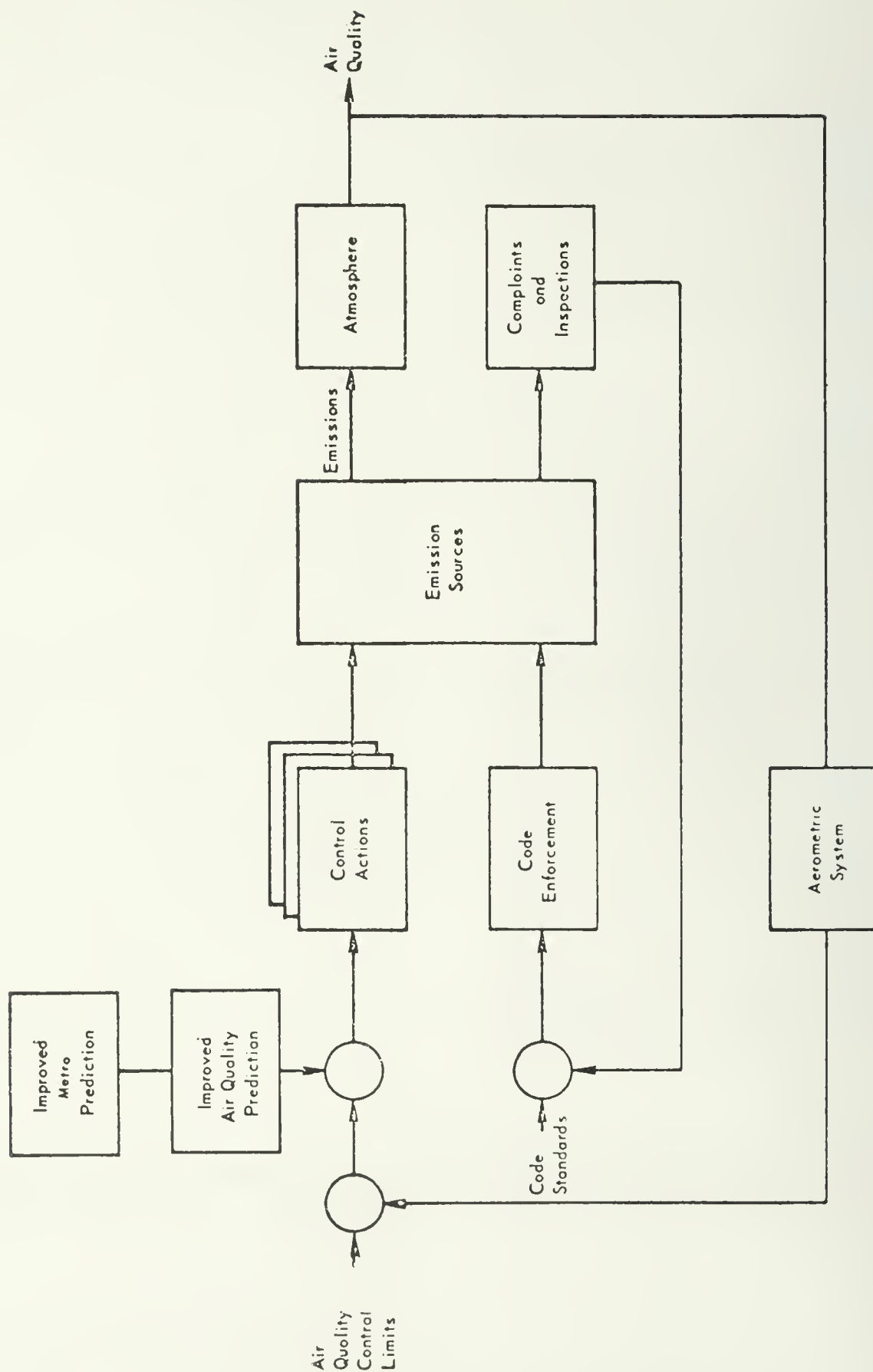


Fig. 1-1 Air Pollution Control System

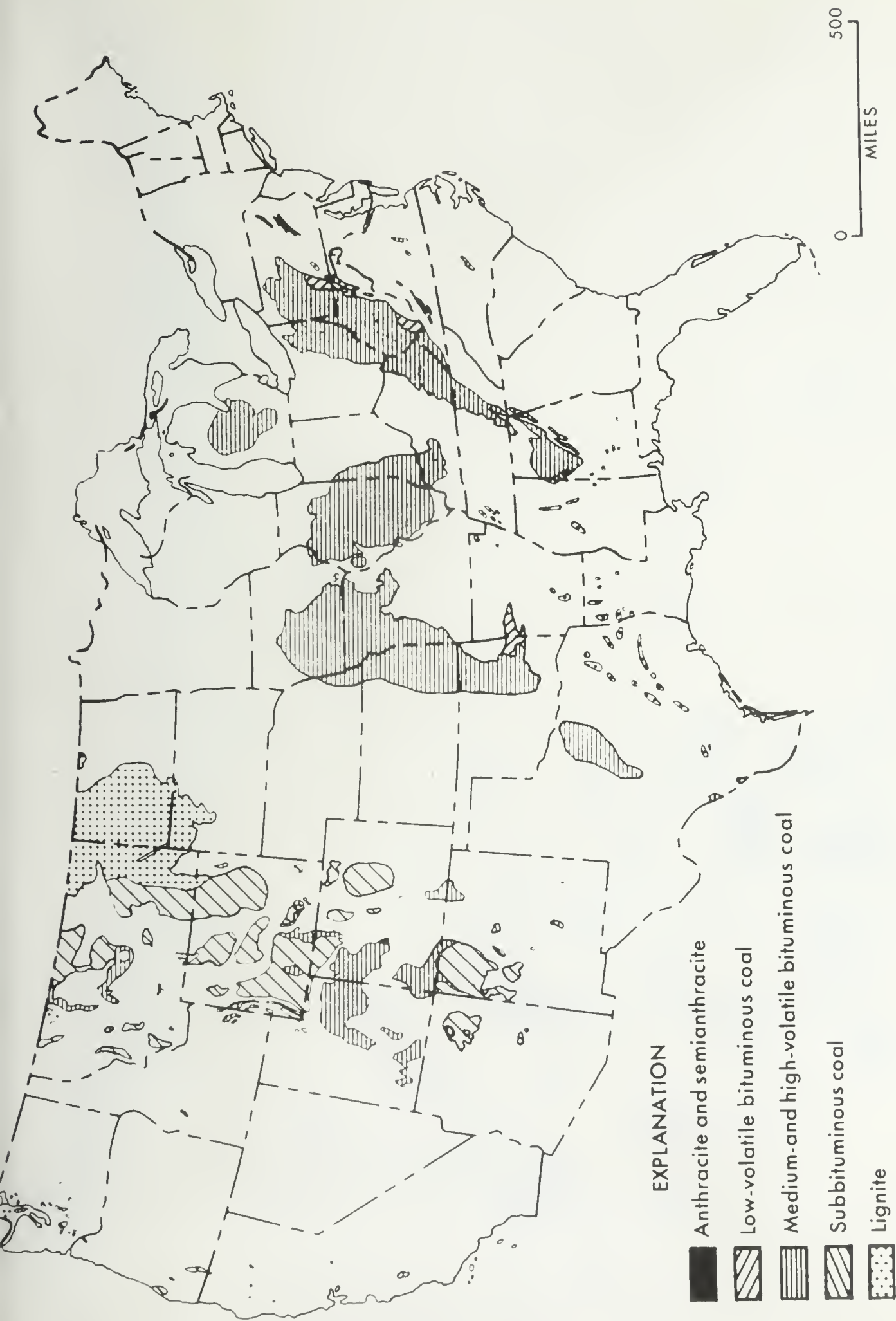


Figure 2-1. Coal fields of the conterminous United States.

2.2 PURPOSE OF THE STUDY SECTION (Resources)

The State of Illinois like other coal-producing states, is faced with the dilemma of desiring to utilize its natural resources while ensuring that legislation governing the use of low-sulfur fuels is reasonable and effective. The Illinois Air Pollution Control Board, while addressing the problem of air pollution control, became concerned about the local availability of indigenous coal as an available fuel to meet growing industrial demands in the state. This study has been undertaken to determine the availability of low sulfur coal to ensure the exploitation of state resources while improving air quality. The purpose of this study was to determine the extent to which low sulfur coal might be available in the Illinois Basin for air pollution control purposes, and to document low sulfur coal availability. This report is supplemented by an extensive coal resources data bank describing the quality of MWCF coal reserves. It is not intended to be a detailed study of the coal geology of the area or a basis for exploitation of low sulfur reserves. Use of the tables in this report should include careful reference to study constraints.

2.3 OBJECTIVES OF THE STUDY SECTION (Resources)

The objectives of the Resources section of the study may be summarized as follows:

- 1. To develop, analyze and consolidate geological data including coal reserves by seam, geographic area and quality (particularly sulfur content).
- 2. To incorporate this data into a machine-readable coal resources data bank,

SECTION 3

3.1 REGIONAL GEOLOGY

Because coal is so infinitely related to geology, some attention to the regional geological conditions contributing to the formation of coal in the Illinois Basin is a necessary preface to this study.

Illinois, Kentucky and Indiana are all part of the Interior Lowland Interior Low Plateau Province. The area is one of low relief with a regional elevation generally less than 1,000 feet above sea level. Most of the coals in the area were deposited in the Illinois Basin, also here called the Midwest Coal Field, (MWCF) which encompasses parts of Illinois, Southwestern Indiana and Western Kentucky (Figure 3-1) in a geological period known as the Pennsylvanian. The Illinois Basin is a spoon-shaped structural depression.

Pennsylvanian sedimentary rocks in Illinois form the bedrock surface of over approximately four-fifths of the state, and reach a maximum composite thickness of about 3,000 feet. Several hundred thin (commonly less than 30 feet) units of sandstone, shale, siltstone, clay, limestone and coal are present in the formations, most of which are of variable thickness and change laterally.

Particularly well-known to geologists is the cyclical sedimentation with which many coals of the MWCF are associated. This sequence, recording a cycle of sedimentation, part of which was formed below sea level, and part of which was formed above sea level is called a *cyclothem*. An ideally complete

cyclothem consists of ten distinct units, (Figure 3-2) although one or more units are usually absent. A particularly noteworthy feature of cyclothem is the clay underlying the coals--designated underclays have been variously interpreted as: 1) marine or fresh water sediment leached by humic acids from the overlying coal swamp; 2) old soils produced before the coal swamps developed; 3) loess (wind blown) deposits, and 4) detritus derived from a low-lying or deeply eroded landmass.

The coal beds themselves were apparently deposited in vast fresh water swamps only a few feet above sea level. Peat deposition in the swamps--which with later compaction formed the coal--was usually terminated by readvancing sea.

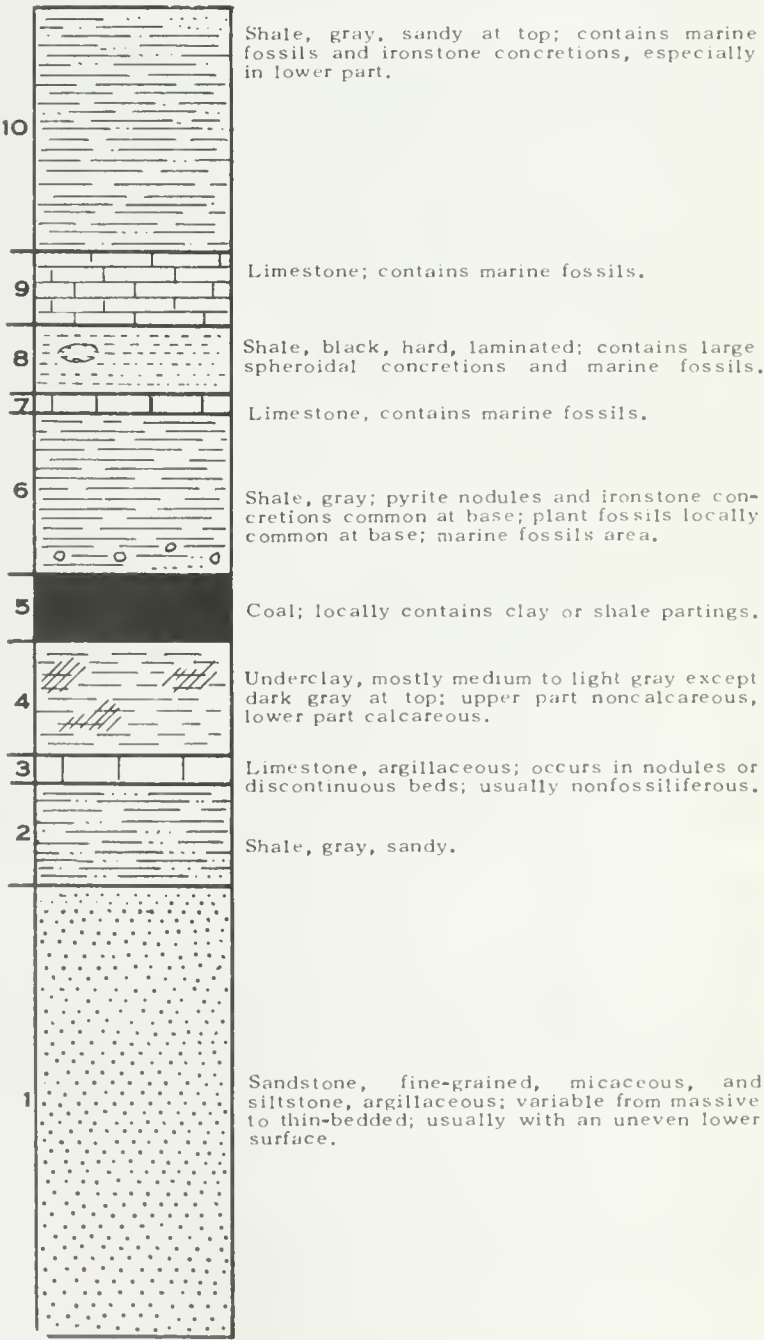


Figure 3-2
AN IDEALLY COMPLETE CYCLOTHEM
From the Illinois State Geological Survey Bulletin
No. 66, Geology and Mineral Resources of the Mar-
seilles, Ottawa, and Streator Quadrangles.

The cyclothems and the repetition of abrupt vertical and lateral changes associated with coal-bearing Pennsylvanian strata indicate that there were a wide range of ancient depositional environments which changed rapidly and regularly with time. The alternation of marine with non-marine sediments in the cyclothem suggests to the geologist that there was frequent invasion and withdrawal of the sea during the formation of each cycle. In general, the lower five units (see Figure 3-2) were deposited on coastal lowlands from which the sea had withdrawn and coal was deposited as peat in the swampy lowland. The higher units were a product of rising sea sedimentation.

Pennsylvanian strata in the MWCF are all contained in a spoon-shaped structural basin termed the Illinois Basin. The deepest part of the present basin lies generally in southeastern Illinois although the thickest remaining section lies in West Kentucky where the Moorman Syncline and related faulting have been responsible for preservation of the thickest section.

In Illinois, the Pennsylvanian rocks, which underlie about 35,000 square miles and which reach a maximum composite thickness of about 2800 feet, are divided into three groups, named in ascending order, McCormick, Kewanee, and McLeansboro, which include seven complex formations—Caseyville, Abbott, Spoon, Carbondale, Modesto, Bond, and Mattoon. Although coals have probably been worked at least locally from all formations, the principal coals mined in Illinois, Danville (No. 7), Herrin (No. 6), Harrisburg-Springfield (No. 5), and Colchester (No. 2), all occur in the Carbondale Formation. Very little coal has been mined from the Caseyville Formation, and no important commercial production has been developed from the Modesto and Bond Formations.

In Indiana, the maximum composite section of about 2100 feet of Pennsylvanian strata underlies about 6500 square miles and is divided into the Raccoon Creek, Carbondale, and McLeansboro Groups, which are divided into ten formations (*in ascending order*): Mansfield, Brazil, Staunton, Linton, Petersburg, Dugger, Shelburn, Patoka, Bond, and Mattoon. The largest amount of coal production and reserves are included in the Carbondale Group.

In West Kentucky, the maximum composite section is estimated to be over 3200 feet in the Moorman Syncline, south of the Rough Creek-Shawneetown Fault. Approximately 4680 square miles in West Kentucky are underlain by Pennsylvanian Strata which are divided into the Caseyville, Tradewater, Carbondale, Lisman, and Henshaw Formations. As in the remainder of the MWCF, most production and reserves occur in the Carbondale Formation. Except for small-scale local production, there has not been any important production from the uppermost Henshaw Formation.

A summary of named coals and correlation chart used in this study is included in Figure 3-4.

In Indiana, the Pennsylvanian rocks are 1,500 feet thick and cover an area of 6,500 square miles. The Pennsylvanian rocks include a basal sandstone overlain by a variable sequence of shale, sandstone, limestone, coal and clay. The rocks are divided into the Pottsville, Allegheny and Post Allegheny groups,

with most of the coal in the Carbondale group of the Allegheny

The depositional environment of Pennsylvanian rocks in West Kentucky is generally considered similar to that of Illinois. The rock outcrop in the eastern and western Kentucky coal fields and cover an area of 4,680 square miles.

The Pennsylvanian in West Kentucky is divided in the Henshaw, Lisman, Carbondale, Tradewater and Caseyville Formations. The Carbondale Formation contains the most productive coal seams in the area

A summary of the stratigraphic units and correlation chart used in this study are included in Figures 3-3 and 3-4 respectively

3.3 SOURCES OF DATA

In the course of the study a variety of sources dating from the late 1880's were examined to provide basic statistical data for the study. Principal contributors to this study are summarized in Figure 3-5 and the relative source emphasis provided in Figure 3-6

Procedural advice was provided by the Illinois Air Pollution Control Board, HEW, Midwest Coal Producers Institute, and the Illinois State Geological Survey. Geological maps published by the U. S. Geological Survey and Illinois, Indiana and Kentucky State Geological Surveys supplemented vast quantities of information obtained from unpublished sources

State Geological Survey mine files furnished data related to coal seam thickness and depth of coal. Some confidential mine data were unavailable for purposes of this study. A major contribution to reserve statistics developed in this study was obtained from the Illinois State Geological Survey. Reserves data for Indiana were obtained from the preliminary coal map series published by the Indiana State-Geological Survey. Reserves data for the west Kentucky were provided by the TVA Fuels Planning Branch, and the U. S. Geological Survey quadrangle maps prepared in cooperation with Kentucky Geological Survey

Coal quality data available from state geological surveys included that obtained through recent HEW contracts.

U. S. Bureau of Mines analysis of coal deliveries to the Federal Government provided useful basic data. Significant (*and not previously utilized quality data*) was obtained from Tennessee Valley Authority Coal Quality Adjustment reports (Figure 3-7)

The value of TVA quality adjustment records lies not only in the quality of data available but also in the fact that various TVA laboratories exchanged samples and cross checked coal quality data, specifically thermal value, sulfur and ash contents.

Cady's (1952) summary of reserves in the State of Illinois (*which have been modified and updated through the years*) and a series of strippable coal reports provided basic data. Indiana reserves have been summarized using the preliminary coal map series. TVA geologists have conducted the most recent analysis of West Kentucky reserves and made a variety of published and unpublished reports and

ILLINOIS COAL STUDY

COAL SEAM DESCRIPTION CHART

Illinois

Figure 3-3

Seam Designator	Alternate Names	Description
Abingdon		This seam is extremely thin. In the type section, it is only represented by a coally streak.
Allenby	Bankston	This is a minor coal occurring below the Danville #7. Data are not adequate to estimate reserves.
Assumption	Bidwell	This is a minor coal occurring below the Litchfield in southwestern Illinois. Data are not adequate for estimating reserves.
Athensville		Athensville is a minor coal occurring below the Scottsville coal in the southwestern part of the state. Data are not adequate for estimating reserves.
Battery Rock Coal		The distribution of this coal is spotty. It is nowhere commercial.
Bidwell		This seam is approximately 72 inches thick.
Briar Hill No. 5		This seam locally reaches a thickness of 28 inches. In most areas, it is too thin to be minable.
Brush	Middle DeLong	Brush coal is discontinuous, and is generally too thin to be minable where it occurs. Data are not adequate to estimate reserves.
Calhoun		This seam averages 16 inches thick.
Chapel No. 8	Trivoli	This seam is a good marker bed. Since it is only 12-15 inches thick, it is not commercial. The roof is black, slaty shale.
Cohn		Cohn coal occurs above Friendsville coal in eastern Illinois. It is a minor seam and data are not adequate for estimating reserves.
Colchester No. 2	Third Vein, III-A, Schultztown, Mendon	This is the most extensive Pennsylvanian coal found in the United States, and is the principal commercial coal of northern Illinois. It ranges from 12-48 inches thick and averages 30 inches thick. There is an estimated 15×10^9 tons of undeveloped reserves and

Seam Designator	Alternate Names	Description
Colchester No. 2	Third Vein, III-A, Schultztown, Mendon	5×10^9 tons of strippable reserves, but it is presently considered too thin to be workable. It is the most uniform stratum in the entire basin, and is absent in less than 5% of the area inside its outcrop line. The "Mendon" coal was locally mined with a maximum thickness of 60 inches, and is probably a thickening of the thinner No. 2 coal to the east.
Danville No. 7	Cutler, Sparland, LaSalle, First Vein	<p>This coal is the highest commercial seam mined in the basin. It is continuous, well-benched and has a thickness ranging from 21-26 inches.</p> <p>The seam is not considered workable, but it may be strip mined or used in underground gasification. The reserves are estimated at 8×10^9 tons underground and 1×10^9 tons strip. It is overlain by 50-100 feet of shale.</p>
Davis		This seam approaches 42 inches in thickness. It is not at present commercial but due to its thickness, it will become commercial when economic conditions warrant. The roof is marine-black shale overlain by limestone.
DeGraff	First Cutler Rider Coal	DeGraff is a minor seam occurring above the Danville #7 coal in the southeastern part of the state.
DeKoven		This coal reaches a maximum of 36 inches in thickness. It is mined locally, generally in conjunction with the Davis coal 15-25 feet below.
DeLong		This coal occurs above the Brush coal in the northern and western parts of the state. It is discontinuous and too thin to be minable where it occurs.
Delwood	Pope Creek	This seam averages 38 inches thick. Data are not adequate for estimating reserves.
Flannigan		Flannigan coal is found in southeastern and eastern Illinois above the New Haven Coal. Data are not adequate for estimating reserves.
Flat Creek		This seam averages 12 inches thick. Data are not adequate for estimating reserves.

Seam Designator	Alternate Names	Description
Friendsville		Friendsville ranges from 36-40 inches thick. Interest is this seam may not develop until existing oil pools are exhausted. The seam will probably be strip mined.
Gentry		This seam is approximately 24 inches thick. Data are not adequate for estimating reserves.
Greenbush		Greenbush coal occurs above the Wiley beds in northern and western Illinois. Data are not adequate for estimating reserves.
Harrisburg-Springfield No. 5	Blair	This seam is the most important commercial coal bed in the basin. It ranges from 0-72 inches thick. The seam gives a high resistivity on electric logs between two reverse peaks representing the roof, black shale and the underclay. Sulfur content of less than 2% has been found locally. The reserves are estimated to be 37×10^9 tons underground and 5×10^9 tons strippable.
Hermon	Miller, DeLong	Hermon is extremely thin, and occurs below the Brush coal in the northern and western part of the state. Because of its thinness, it is unimportant.
Herin No. 6	Belleville, Breneton, LaSalle	This is the main coal of Illinois. It has the largest track of low sulfur content in the state, between .5 and .6%. The average thickness is 60 inches and the maximum 168. This seam has 2 or 3 clay partings from 1/8 to 3 inches thick. 63% of the reserves (estimated at $.83 \times 10^9$ tons), are easily cleaned. The seam is expected to be exhausted by 1985. No. 6 commonly has softening temperature greater than 2200°F .
Jamestown		This is a wide-spread but thin seam which is mined locally.
Kerton Creek		The Kerton Creek coal is a thin, lenticular seam occurring locally below the Sumnum Bed. Data are not adequate for estimating reserves -- which are considered unimportant.
Lake Creek		Lake Creek coal is found below the Chapel #8 in the southeastern part of the state. Data are not adequate for estimating reserves, which are considered slight.

Seam Designator	Alternate Names	Description
Litchfield		Litchfield is an unimportant seam below the Murpheysboro in the southwestern part of the state. Data are not adequate for estimating reserves.
Lowell		This is an insignificant seam occurring above the Colchester #2 in the northern and western part of the state. Data are not adequate for estimating reserves.
Makanda		Makanda is a thin, lenticular coal which is generally less than 18 inches thick. Data are not adequate for estimating reserves.
McLeary's Bluff		McLeary's Bluff coal is an insignificant bed above the Friendsville coal in the southeastern part of the state. Data are not adequate for estimating reserves.
Mt. Rorah	Bald Hill	The Mt. Rorah seam is approximately 24 inches thick. The bed lies 75-100 feet below the Davis bed.
Murpheysboro		This is a series of thin seams from 12-90 inches thick separated by shale partings. It is workable only locally and is overlain by sandstone.
New Burnside		This seam averages 38 inches thick. It occurs below the C'Nan in the southeastern part of the state. Data are not adequate for estimating reserves.
New Haven		New Haven coal is an insignificant seam occurring below the Flanagan coal in the southeastern and southwestern parts of the state. Data are not adequate for estimating reserves.
C'Nan	Culew	The coal is considered insignificant. Data are not adequate for estimating reserves.
Opdyke		Opdyke occurs below the Trowbridge coal in the southeastern part of the state. It is not considered significant.
Pond Creek	2nd Rider Coal	Pond Creek is an insignificant coal below Lake Creek coal. Data are not adequate for estimating reserves.

Seam Designator	Alternate Names	Description
Pope Creek		Pope Creek is found above the Tarter coal in the northern and western parts of the state. It is an insignificant coal and data are not adequate for estimating reserves.
Reynoldsburg		Reynoldsburg coal averages 28 inches in thickness. It is found above the Gentry coal in the southeastern part of the state. Data are not adequate for estimating reserves.
Rock Branch	Scottsville	This coal is found above the Danville #7 in the southwestern part of the state. Data are not adequate for estimating reserves.
Rock Island No. 1	Curlew	Rock Island No. 1 averages 30-36 inches thick and has a maximum thickness of 82 inches. The seam lies in an elongate estuary-like basin less than one mile wide. It wedges out at the margins and narrows to the southeast. Within the troughs, the coal is 48-60 inches thick. Rock Island No. 1 is mined only locally. Much of the seam is drift covered and underlain by sandstone.
Roodhouse		Roodhouse coal occurs below the Sumnum #4 in the southwestern part of the state. It is an insignificant seam and data are not adequate for estimating reserves.
Scottsville	Cutler Rider	Scottsville coal occurs below Chapel #8 in the southwestern part of the state. It is considered an insignificant seam, and data are not adequate for estimating reserves.
Seahorne		This coal is slightly lenticular. It occurs below the Wiley coal in the western parts of the State. The coal is considered insignificant and data are not adequate for estimating reserves.
Seelyville		Seelyville coal occurs below the Colchester #2 coal. Data are not adequate for estimating reserves.
Shawneetown (2-a)	No. 2-a	Shawneetown coal averages 10 inches thick, and is found above the Colchester #2 coal in the southeastern part of the state. Data are not adequate for estimating reserves.

Seam Designator	Alternate Names	Description
Shelbyville		Shelbyville coal occurs below the Opdyke coal in the central and southeastern parts of the State. It is an insignificant coal and data are not adequate for estimating reserves.
Summun No. 4	Eastern Area No. 5	Summun No. 4 is less than 18 inches thick, and it averages 4 inches thick. It is minable only locally. The bed is overlain by shale with the largest concretions that occur in the basin. It is underlain by clay.
Tarter	Willis	Tarter coal is a thin (2-4 inches thick) coal found in the northern and western parts of the state. It is insignificant and data are not adequate for estimating reserves.
Trowbridge		Trowbridge coal is an insignificant seam below the Calhoun coal in the southeastern part of the state. Data are not adequate for estimating reserves.
Wiley		Wiley coal occurs above the Seahorne coal in the northern and western part of the state. It is a discontinuous seam, too thin to be minable. It averages ten inches thick in its type locality.
Wise Ridge	Stonefort	Wise Ridge coal averages about 12 inches in thickness. Data are inadequate for estimating reserves.
Witt		Witt averages 12 inches thick. Data are not adequate for estimating reserves.
Womac	Macoupin	Womac coal averages eight inches in thickness. The coal occurs above the Chapel #8 in the southwestern part of the state. Data are not adequate for estimating reserves.

Seam Designator	Alternate Names	Description
Coal I	French Lick, St. Meinrad	This is the lowest seam of commercial importance in Indiana. It is 12 to 48 inches thick and has an average thickness of 36 inches. Coal I (St. Meinrad) occurs in counties along the eastern edge of the coal field and is currently being mined in Perry County where it averages 48 inches in thickness). Coal was deposited in relatively small basins and thins towards the margins of each basin. In some localities, it is split by a clay parting. The roof formation is either sandstone or shale. In Perry County where moderate reserves exist, it is generally less than 28 inches thick and is used mainly for local consumption. All the reserves are in the underground mining category.
Coal I-a	Pinnick	This seam averages 12 inches thick, but locally reaches 96 inches thick. The seam is generally considered too thin to be minable.
Coal III	Seelyville, Rock Creek, Staunton, Lower Hanging Rock	This seam is best developed in Clay, Vigo and Dubois Counties. In most other areas, it is too thin to be minable. Coal III averages 72 inches thick and reaches a maximum of 132 inches thick. The seam may be divided into benches by clay and shale partings 1 to 30 inches thick. When it is mined, the coal must be mechanically cleaned to meet the mid-west market competition. It is reportedly a high sulfur and medium to high ash coal. Coals mined between the Coal III and Minshall are relatively small, but have no official names. Many are of limited lateral extent.
Coal III-a	Colchester, Velpen, Upper Hanging Rock, Coal III rider	Coal III-a averages 7-12 inches thick and reaches a maximum of 29 inches thick. Nodular limestones occur throughout the seam. Few data are available to estimate reserves which are believed to be limited; it is minable only locally.
Coal IV	Survant, Linton, Elnora (?)	This seam is well developed in Greene, Vigo and Sullivan Counties where it has an average thickness of 60 inches and a maximum of 84 inches. It is thin elsewhere. It has erroneously been called Coal IV in Sullivan and Greene Counties, and Coal VII in Clay, Vigo, and Vermillion Counties. In many places, it is split into two beds by a parting and is reportedly low in sulfur and ash. Where the parting is not present, little or no cleaning is required to produce a satisfactory product for available markets.

Figure 3-3 (continued)

Indiana (Cont.)

Seam Designator	Alternate Names	Description
Coal IV - a	Houchin Creek Coal IV rider	This is the rider coal above Coal IV and is especially well developed in southwest Pike County. Its thickness ranges from 20 to 36 inches. It is mined locally when the bed is very thick. Due to the thinness and inadequate drilling information, few data are available to estimate reserves.
Coal V	Alum, Alum Cave, Springfield, Newberg, Petersburg	This is the most important seam in Indiana with an average thickness of 60 inches and a maximum thickness of 132 inches. The only partings of note occur in northeast Warrick County where medial partings of 12 to 120 inches are present. Concretions in the overlying shale beds often extend into the coal. Mechanical cleaning is generally required and particularly in Warrick County.
Coal V-a	Coal V rider	Coal V-a varies from 1 to 36 inches thick. Because it rarely exceeds 14 inches, it is considered too thin to be of commercial interest.
Coal V-b	Grape Creek Coal V rider	V-b occurs as a Rider above Coal V and is generally too thin to be commercially mined. The bed has no significant reserves, but has been worked in Vermillion and Sullivan Counties.
Coal VI	Lower Millersburg Hymera, Drugger	Coal VI varies from 54 to 96 inches thick and is thickest in the northern part of the state. The lowest 12 inches of the seam is an impure bone coal. There are two thin shale partings -- about 5 inches apart, and one-half inch thick -- occur near the center of the seam. It has a medium ash and sulfur content; where pyrite is abundant, mechanical cleaning has proven successful in reducing sulfur levels. A coal designated Coal VI-a occurs in some places over Coal VI.
Coal VII	Upper Millersburg Danville	Coal VII is 30 to 72 inches thick, and underlies large areas as a continuous bed. It has a roof of shale or sandstone. An interval of 45 feet separates Coal VII from Coal VI in the northern parts of the field; southward, the interval decreases to only a few feet and both can be mined together. It is a medium to high sulfur coal, low in ash. Coal VII has a rider

Seam Designator	Alternate Names	Description
Coal VII	Lebanon Millersburg, Danville	coal designated Coal VII-a. A Coal VII-b, six to twelve inches thick occurs in Posey County. Both, however, have no significant reserves.
Blue Creek		This is a minor coal generally less than 24 inches thick. It is too thin to be minable, and reserves are quite limited.
Cannelton		This is a minor coal found only in local basins and has no significant reserves.
Cohn Coal		The Cohn coal is an average of 2 inches thick. It has been mined on a small scale when the thickness was greater than 12 inches.
Dale		Dale coal occurs between the Ferdinand and Block coals. It is considered insignificant and data are not adequate for estimating reserves.
Davis		This seam approaches 42 inches thick. It is not at present commercial, but due to its thickness, it will become commercial when economic conditions warrant. The roof is marine-black shale overlain by limestone.
DeKoven		This coal reaches a maximum of 36 inches in thickness. It is mined locally, generally in conjunction with the Davis coal 15-25 feet below.
Ditney		The Ditney seam is less than 12 inches thick and is not commercially exploitable.
Fairbanks		Fairbanks coal locally reaches a maximum thickness of 48 inches. It occurs above the Parker coal. Data are not adequate for estimating reserves.
Friendsville		This seam, approximately 12 inches thick, is poorly developed in the state, but well developed in Illinois. (See Illinois.)
Ferdinand		Ferdinand coal occurs below the Dale coal. It is considered insignificant and data are not adequate for estimating reserves.
Hazleton Bridge		Hazleton Bridge coal occurs between the Ditney and Parker coals. It is considered insignificant, and data are not adequate for estimating reserves.

Seam Designator	Alternate Names	Description
Holland		Holland coal occurs above the Silverwood coal. It is considered an insignificant seam, and data are not adequate for estimating reserves.
Lower Block	Semi-block, Number 1	The seam averages 36 inches in thickness, and reportedly has a low sulfur and ash content. Below the thickest part of the bed there is a layer or two of soft or bone coal separated from the block coal by clay. This is the oldest coal of commercial importance in the State. It is mined extensively in the Brazil district. Due to small stratigraphic interval between it and the Upper Block, both are often mined together. With careful loading procedures, little cleaning has been required to date.
Mariah Hill	Huntingburg, Jasper	The Mariah Hill coal is 24 to 72 inches thick. Where it is thickest, it is mined for local consumption. It is relatively clean coal. It is currently being mined in Spencer County and is reportedly of medium sulfur and ash content.
McLeary's Bluff		This seam, from 1 to 7 inches thick, occurs in a small area in Gibson and Posey Counties and has no significant reserves.
Minshall	Block Rider Buffaloville II	The Minshall coal averages 30 inches with a maximum thickness of 72 inches. It occurs in small lenticular deposits and is used largely for local consumption. It is considered a free burning coal, and is generally higher in sulfur and ash than Block coals.
Parker		Parker is 12 inches thick and is not considered a commercially exploitable coal. Data are not adequate for estimating reserves.
Silverwood		Thickness of this seam varies greatly, but in the workable areas (which are rare), it ranges from 24 to 42 inches. The bed contains clay partings in many areas. It has no significant reserves.
Upper Block	Number 2	The Upper Block averages 36 inches (with a maximum of 60 inches) thick. A little below the middle of the seam, there is a hard, brittle coal bed 3 inches thick. The Upper Block is separated from the Lower Block by 30 feet of clay, shale and sandstone. Although the

Seam Designator	Alternate Names	Description
Upper Block	Number 2	Upper Block has the same thickness, character and distribution as the Lower Block, commercial exploitation is limited to Western Indiana.

Seam Designator	Alternate Names	Description
1-a	Persimmon Run	This seam is thin and lenticular, but may locally thicken to 60 inches. The coal has been worked out in most areas.
1-b	Bell, Cook, Casey	This seam varies from 0 to 57 inches in thickness, with an average thickness of 36 inches. It is the lowest coal in the area with commercial possibilities.
3	Ice House, Aberdeen (?), James Mason, Mud River	This seam ranges from 28 to 34 inches in thickness. It occurs in lenticular pockets, and in some places may split into several thinner seams.
4	Beda, Mannington, Top Miller (?), Curlew, Empire, Dawson Springs	A variety of names have been used for Number 4 because many mines were independently open at widely separated points. The seam ranges from 0 to 72 inches and averages 42 inches thick. It is extensively folded, of variable quality, but commands a premium price when it is high quality. Soft bands containing a high percentage of ash occur throughout the seam. Several beds of thin stray coals are often found above Number 4. Reserves have been depleted in some places.
5	Mill Site	Seam Number 5 ranges from 30 to 36 inches thick, and occasionally reaches a maximum thickness of 60 inches. It is lenticular, and is not considered commercially significant at the present time.
6	Davis, Four Foot Coal, John Waltham, Beaver Dam	The Number 6 coal is a regionally persistent seam which is not commercially exploited at present. The seam is usually thin, but reaches a maximum of 48 inches in thickness. It has banded pyrite inclusions and has been both stripped and underground mined. Several small coals occur below the Number 6 and may support small strip mines.
7	DeKoven, Three Foot Seam, Sam Waltham Coal	This is a discontinuous, thin seam which locally reaches a maximum thickness of 44 inches. Its great depth and the availability of more easily mined coal seams limit its exploitation at present; future development is possible, however.
8	Well	This seam is generally thin, but where its thickness exceeds 30 inches, it is strip mined locally and has often proved too impure to be mined profitably.

Seam Designator	Alternate Names	Description
8-b	Upper Well, Goshen Coal	The Number 8-b coal averages 18 inches thick, but its thickness is highly variable. It is overlain by a thin bed of black shale and is of no commercial significance.
9		This seam comprises more than 70% of the reported reserves in western Kentucky. It is one of the most consistent and persistent seams in the United States, with an average thickness of 36-72 inches. The seam has been mined extensively, but oil and gas drilling have interfered with the mining processes. The coal has a high sulfur content and is not good for coking. The slate roof enhances its generally excellent receiving conditions.
10		The Number 10 coal averages 12 inches thick. It reaches a maximum of 84 inches thick only locally. The seam has recently been mined by strip methods but supports only small mining operations. A group of thin soft ashy coals occur between the Number 9 and Number 10 coals and has been locally stripped.
11	Briar Hill	This is the second most important seam in western Kentucky. It is somewhat dirtier than the Number 9 and slightly lower in ash content. The seam averages 75 inches in thickness and reaches a maximum thickness of 84 inches. When possible, surface mining is desirable in order to also recover Number 12 which is about 12 feet above Number 11. The roof is marine limestone. The seam contains a persistent blue band parting from 1 to 3 inches thick in the lower third of the seam.
12		This seam is generally of poor quality. It averages 48 inches in thickness with a maximum of 72 inches. Since the roof conditions are considered poor for mining, the seam is not mined except in conjunction with Number 11.
13		The Number 13 coal averages 48-72 inches and reaches a maximum of 144 inches in thickness. In some areas, the seam may be split into two benches by an 8 to 36 inch parting. The seam is locally commercial and it contains an estimated 9% of the reserves of the area. In places, the seam is discontinuous. The soft clay roof requires special support. It is often mined as a by-product of lower seam stripping.
	Baker, Nebo	

Seam Designator	Alternate Names	Description
14	Green River	The reserves in this seam are largely depleted. Coal is found only locally, and the seam is very erratic in thickness. The roof condition is poor, consisting of soft clay and shale. A few small beds between the Number 13 and Number 14 have supported a few local mines but are generally too thin for commercial exploitation.
15		The Number 15 coal averages 18 inches thick. The seam is lenticular and discontinuous and is too thin for commercial exploitation. Coals between the Number 14 and Number 15 are thin and discontinuous and not considered minable under present economic conditions. Coal Number 15-a and other small coals above the Number 15 coal are too thin to be commercially attractive.
Amos	Gidcomb	This seam averages 18 inches in thickness and has a silica-rich slate roof. To date it has been used only for local consumption.
Battery Rock		Battery Rock coal is a thin seam occurring below the Number 1 (a) in western Kentucky. Data are not adequate to estimate reserves.
Belton	Number 6 (?)	The Belton coal is mined commercially, and is largely mined out.
Cates		This seam locally reaches 36 inches in thickness. The minable areas are small, and it is not believed to have significant reserves.
Deanfield		The Deanfield coal overlies the Hawesville seam. It is discontinuous. The roof contains cobbles of marcasite sandstone. It is a maximum of 48 inches thick.
Dunbar	Elm Lick	This seam averages 36 to 44 inches in thickness with a few clay partings. It is largely mined for local consumption.
Elmwood		The Elmwood coal reaches a maximum of 24 inches in thickness, and is generally too thin to be of commercial interest.

Seam Designator	Alternate Names	Description
Foster		The Foster coal averages 24 inches in thickness. While it can be low in sulfur, it is used largely for local consumption at the present time.
Geiger Lake		This coal reaches an average thickness of 24 inches, and is mined only on a local scale.
Hawesville		This coal varies from 24 to 48 inches in thickness. The seam is generally low in sulfur, lenticular and areally discontinuous. It is presently of local importance and has been largely mined out in some areas. The earliest production was from low sulfur coal which is largely exhausted, and remainder is not considered recoverable. Some pockets of thick coal may yet be undiscovered.
Lead Creek		The Lead Creek coal is a maximum of 48 inches thick, but is often too thin and lenticular to be commercially minable. There are no large reserves. Coal produced has been largely for domestic use, and one report suggests thinness of coal did not warrant removal of overlying limestone.
Lewisport	Red Ash	This seam reaches a maximum of 48 inches thick, and may be split in places and overlain by up to seven feet of limestone. The seam has been mined extensively, where present (thick), and there are few remaining reserves.
Lower Otter Creek	Lisman	This seam is generally persistent, averages 30 inches thick, and locally reaches a maximum thickness of 55 inches. It is locally mined underground.
Main Nolin	Nolin	This seam averages 36 inches thick. Due to variation in thickness and quality at different localities, it is largely mined locally. It has a good roof, but is probably not regionally continuous over large areas.
Mining City		This is a minor coal which was deposited thirty feet above the Curlew limestone in western Kentucky. Data are not adequate for estimating reserves.
Pottsville-2		The Pottsville 2 coal is discontinuous, and 12 to 18 inches thick where it occurs. Its potential for commercial exploitation is limited.

Seam Designator	Alternate Names	Description
Pottsville-3		The Pottsville-3 coal is persistent in Edmonson County but has been identified in a few other places.
Pottsville-4		The Pottsville-4 coal is thin, and is not considered to have workable reserves.
Schultztown		The Schultztown coal is relatively widespread, and an important marker bed, but is too thin to have significant reserves.
Upper Otter Creek		This seam is thin-to-absent in most places, but may reach 74 inches in thickness. It is extremely variable in thickness and in physical characteristic and is of limited commercial value at the present time. There is a series of six insignificant (thin) coals above the Otter Creek.
White Ash	Adair	The White Ash coal reaches a maximum of 48 inches thick, occurs only locally and does not appear to have significant reserves. It has been stripped in the Pellville Quadrangle as late as 1963.

Relative stratigraphic relationships of major and minor coals in the Eastern Interior Basin

North and West Illinois	Southwest Illinois	Southeast Illinois	Eastern Illinois	Indiana	Western Kentucky	Eastern West Kentucky Southern Part	Eastern West Kentucky Northern Part
		Calhoun			Geiger Lake		
		Trowbridge					
		Opdyke					
		Shelbyville					
		McCleary's Bluff					
		Friendsville	Cohn				
	Witt						
	Flat Creek			Fairbanks	Upper Otter Creek Lower Otter Creek		
	New Haven	Flannigan					
		New Haven		Parker			
	Womac			Hazleton Bridge			
No. 8	No. 8	No. 8	No. 8	Ditney	No. 15		
	Scottsville	Lake Creek					
	Athensville						
		Pond Creek					

Relative stratigraphic relationships of major and minor coals in the Eastern Interior Basin

North and West Illinois	Southwest Illinois	Southeast Illinois	Eastern Illinois	Indiana	Western Kentucky	Eastern West Kentucky Southern Port	Eastern West Kentucky Northern Port
	Rock Branch						
		De Graff					
Danville No. 7	No. 7	No. 7	No. 7	Danville (VII)	No. 14		
		Allenby			No. 13		
	Jamestown	Jamestown	Jamestown	Hymera (VI)	No. 12		
Herrin No. 6	No. 6	No. 6	No. 6	Herrin	No. 11		
	Briar Hill	Briar Hill		Bucktown (VB)	No. 10		
Springfield No. 5	Harrisburg No. 5	Harrisburg No. 5	Harrisburg No. 5	Springfield (V)	No. 9	No. 9	
No. 4	No. 4	No. 4	No. 4	Houchin Creek (IVA)	No. 8B	No. 8B	
Kerton Creek	Roadhouse						
		Shawneetown		Survont (IV)	No. 8	No. 8	
Lowell	Lowell						
Colchester No. 2	No. 2	No. 2	No. 2	Colchester (IIIA)	Schultztown	Schultztown	
Abingdon							
		Seelyville	Seelyville	Seelyville (III)	Seelyville		
Greenbush	Dekoven	Dekoven		Dekoven	No. 7		
Wiley	Davis	Davis			No. 6	No. 6	

Relative stratigraphic relationships of major and minor coals in the Eastern Interior Basin

North and West Illinois	Southwest Illinois	Southeast Illinois	Eastern Illinois	Indiana	Western Kentucky	Eastern West Kentucky Southern Part	Eastern West Kentucky Northern Part
Seohorne							
		Wise Ridge				Lewisport	
DeLong		Mt. Rorah				Belton	
Brush							White Ash
Hermon		O'Nan			No. 5	Mining City	
					Cates	Cates	
No. 1	Murpheysboro	New Burnside		Minshall	No. 4	Dawson Springs	
	Litchfield						
	Assumption	Bidwell					
	Makando						
							Dunbar
Pope Creek		Delwood		Upper Block	No. 3		
Willis				Lower Block	No. 1B	Foster	
				Shady Lone			
						Amos	
							Lead Creek
						Pottsville No. 4	

Relative stratigraphic relationships of major and minor coals in the Eastern Interior Basin

North and West Illinois	Southwest Illinois	Southeast Illinois	Eastern Illinois	Indiana	Western Kentucky	Eastern West Kentucky Southern Part	Eastern West Kentucky Northern Part
						Pottsville No. 3	
		Reynoldsburg			No. 1A	Pottsville No. 2	Deanfield
		Gentry	Battery Rock	Mariah Hill	Battery Rock	Main Nolin	Hawesville
				Blue Creek			
				Pinnick			
				St. Meinrad			
				French Lick			
				Cannelton			

From "Compendium of Rock Unit Stratigraphy in Indiana,"
by Robert H. Shaver et al., Geological Survey Bulletin 43,
Indiana Department of Natural Resources, 229 pp., 1970.

open file reference maps available for the study. Hodgson (1963) and Mullins (personal communications, 1970) describe the TVA's West Kentucky reserves estimate as conservative but comprehensive. Because some areas were unmapped by TVA, supplementary reserves estimated were completed as part of this report with the assistance of the Kentucky State Geological Survey.

The majority of the reserves data available for all three states required varying degrees of modification and extensive development of basic working materials for use in this study. The TVA approach to reserves problems in West Kentucky was the most closely related in methodology to the IBM approach. TVA reserves maps or data were available for most seams and adjustments were made for mined out areas, coal under flood plains or towns, and heavily drilled areas.

Open file reports, unpublished maps, field notes, manuscripts, and extensive files of samples, cores, and drilling logs were used for reference to fill data gaps.

Producer-related data including mine data, production figures, mining equipment, and general production information were available from the Departments of Mines and Minerals in Illinois, Indiana and Kentucky. Illinois, Indiana, and Kentucky have published data related to coal production annually.

3.4 FACTORS IMPACTING THE STUDY (Resources)

It is probable that continuing research will modify some of the conclusions of this study. Active state and Federal programs are underway to further define MWCF reserves and coal quality. Developing technology can impact the exploration and the recoverability of sulfur coal reserves.

Related to the continuance of a healthy state mining industry, while reducing sulfur emissions, are activities related to the production of pipeline gas and liquid fuels from coal. The U.S. Bureau of Mines is investigating the chemical and mineralogical composition, as well as physical characteristics of available coal reserves, to evaluate the possibility of converting various coals to liquid and gaseous fuels. Their efforts have been largely placed on developing and testing suitable processes, and evaluating the engineering aspects of the plants which might produce such fuels.

Work by NAPCA (Kelly Janes, personal communication, 1969) is being conducted to assess the washability of coals in the MWCF as a possible means of utilizing high sulfur reserves, washed to low sulfur market products.

It should be noted that the data base upon which reserves estimates (or coal quality estimates) are based is a relatively fluid one and that newly available well records or coal quality analysis can modify the results presented here. For example, TVA active core drilling in some areas combined with supporting field activities may update previous TVA reserve estimates. Furthermore, the U. S. Geological Survey has yet to complete geological mapping throughout the west Kentucky area. In Indiana and Illinois, active mapping programs by State Geological Survey has yet to complete geological mapping programs by State Geological Survey geologists will likewise permit reserves estimates to be adjusted.

New information on coal quality is regularly becoming available. Illinois State Geological Survey personnel are examining the forms and distribution of sulfur in coal. Widely distributed samples have been collected to assess sulfur content and the susceptibility of various coals to cleaning process. Comparable work is in progress at the Indiana State Geological Survey. The Kentucky State Geological Survey is gathering coal quality statistical data for eastern and western Kentucky which will probably not be fully available until 1973.

Progress is also being made in analyzing coal seam sedimentation which, when completed, may assist in the location of low sulfur coal.

Wanless (1969) while not addressing the relationships between sulfur, ash, or thermal content, published several studies to identify various coal seams with the environmental conditions under which each accumulated. Further investigations which evaluate the response of such factors as sulfur content to changing environments might lead in time to an indirect method of locating areas of low sulfur accumulation. It should, however, be pointed out that such techniques are relatively time-consuming and and that stack cleaning technology might be available prior to an applied environmental approach for locating additional low sulfur coal reserves.

Of special interest in evaluating the quality of deeply buried or otherwise inaccessible coal reserves is the progress in the use of electric well-logging technology. The value of using well logs for these purposes has not been fully determined. Suffice to say that thousands of well logs are available from holes drilled for oil and gas in the mid-continent region, and these records can provide valuable information concerning depth of over-burden and thickness of coal beds.

SECTION 4

4.1 GENERAL STUDY APPROACH (Resources)

Quantitative data in this report were developed principally by thorough analysis of published literature over the past 50 years, and unpublished state and Federal files. Reserves estimates are presumed to be less conservative than past estimates largely because of the methods used to compute reserves, and the requirements placed on the study team to provide data using sound -- but not necessarily available and standardized -- geological methods.

Data in this report may be classified in two broad statistical groups:

Mine and Production Statistics

Each mine and the company which operates that mine were identified and described. Basic identification information, including its location, ownership, method of production, extent of reserves and (where available) dedication of those reserves were summarized. The annual production of raw and clean coal for each seam was specified for 1969, and mine production estimated with producer assistance to 1973.

Coal Resources (Reserves & Quality) Statistics

Quantity and quality of coal for given geographic

CONTRIBUTIONS

AGENCIES

	General Guidance	Unpublished References – Reserves	Unpublished References – Quality	Basic Geological or Topographic Maps	Coal Seam and Reserve Maps	Published References – Reserves	Published References – Quality	Production Data	Mail Surveys
U. S. Geological Survey				0		X	X		
U. S. Bureau of Mines			0			X	0	X	
Tennessee Valley Authority		0			0	X			
Office of Coal Research	X								
H.E.W.	0		X						
Indiana Geol. Survey	X	0	0	0	0	0	0		
Illinois Geol. Survey	0	0	0	0	0	0	0		
Kentucky Geol. Survey	X		0	X	X	0	0		
Illinois Air Pollution Control Board	0								
Ill., Indiana & Kentucky Depts. of Mines & Minerals	X							0	
Midwest Coal Producers Inst.	0					X		0	0
Private Coal Companies		0						0	0
Railroad Companies						X			
National Coal Association						X		X	

Fig. 3-5 The above agencies provided the study with useful data in the categories listed and are considered significant sources of future data as well.

LEGEND: (X) Contribution (0) Principal contribution.

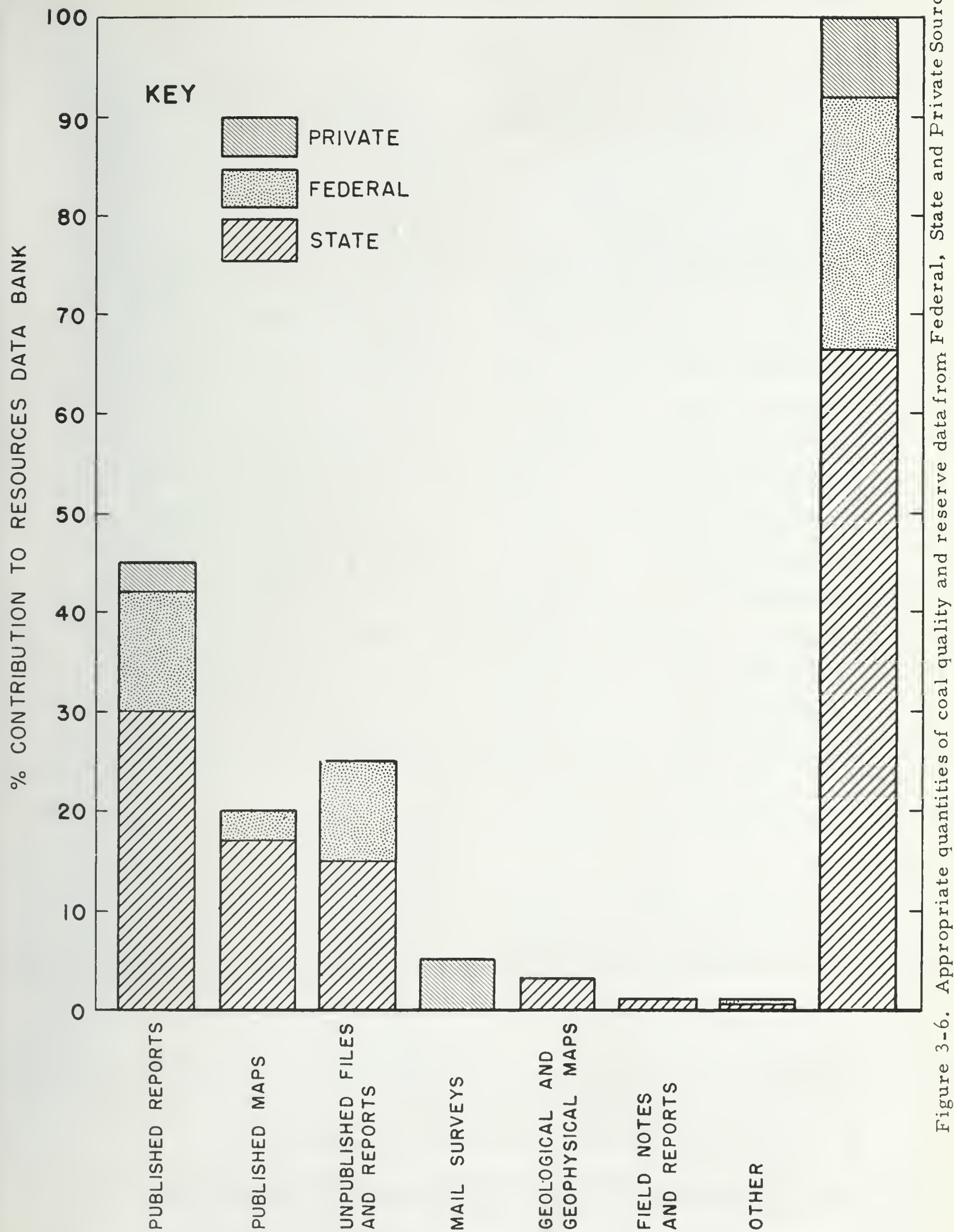


Figure 3-6. Appropriate quantities of coal quality and reserve data from Federal, State and Private Sources.

Figure 3-7.

TVA 8088-A (FD-1-61)

NO. 10887
10887TENNESSEE VALLEY AUTHORITY
COAL QUALITY ADJUSTMENT REPORT

Contractor					Date October 15, 1969		
Producer					Contract No.		
Beginning Date July, 1969					Receiving Period -		
Ending Date September, 1969					Received at Widows Creek Steam Plant		
Guaranteed Delivered Btu = 11,800					Guaranteed Analysis		
Total Moisture					A & M Free Btu		
Sample No.					Loads Sampled		
					RR Car Truck Barge		
WC-5526-R					4.7		
WC-5552-R					60		
WC-5584-R					60		
WC-5610-R					60		
WC-5653-R					60		
WC-5671-R					60		
WC-5679-R					60		
WC-5712-R					60		
WC-5724-R					60		
WC-5757-R					60		
WC-5759-R					37		
Totals					Weighted Averages		
11 S					624		
8.9					23.2		
4.2					14,070		
$14,070 \times \frac{(100-23.2)}{100} \times \frac{(100-8.9)}{100} = 9,844$					$22.45 - 0.1[(23.2+4.2)-5] = 20.21$		
$\frac{20.21}{1,000,000} \times (9,844 \times 2,000) = \3.98					$\$3.98 - \$4.98 = - \$1.00 \text{ Decrease}$		
Quality Adjustment					MTL 10-16-69 R16		
Tons Received 69532.85					Adj. Per Ton \$1.00		
Total Adjustment \$69,532.85					<input type="checkbox"/> Increase <input checked="" type="checkbox"/> Decrease		
Distribution of Copies:					Approved by		
1 - Contractor					Eva R. Matten		
2 - Auditing Branch					(Signature)		
3 - Power Accounting Branch					Stores Record Clerk		
4 - Contractor					(Title)		
5 - Contractor							
6 - Coal Procurement Branch							
7 - Fuels Planning Staff							
8 - Power Production Division							
9 - Plant or terminal							

areas were described. Quality statistics include sulfur in three categories, ash content, free-swelling index, and ash softening temperature.

This statistical data has been prepared in machine-readable form after geological analysis. The data in this study is current to January 1, 1970 and little data available after that date were entered. Documentation of procedures used is intended to facilitate assessment of the statistical base and the validity of the results by the interested reader.

The basic procedural question was the emphasis to be given producer or literature data sources. Producers were believed to possess significant information on coal quality and reserves unavailable in published documents. It was recognized early in the study that both of these sources must be utilized, and requests for producer data were made to supplement published and otherwise available sources. New data made available by producers permitted the updating of state coal quality and reserves estimates. Because some producer data was supplied in confidence to the Midwest Coal Producers Institute, control procedures to handle confidential information were used. Confidential data was returned to Midwest Coal Producers Institute for disposition or storage.

To obtain the satisfactory coal thickness or depth of overburden data, it was often necessary (a) to validate seam names which might vary with time; and (b) to convert data to the geographic base approved for the study.

4.2 METHODOLOGY

4.2.1 Geographic Base

Four geographic levels are incorporated as part of this study: total area (MWCF), state, county, and unit area. The basic geographic designator or *unit area* is the township in Illinois and Indiana, an area of approximately 36 square miles, and the 7½-minute quadrangle of approximately 58 square miles in West Kentucky.

In Illinois and Indiana, the Rectangular (Township) Range Grid System was selected based upon (a) *projected data use* by the Illinois Air Pollution Control Board which would be facilitated by use of a well-established and well-understood system; (b) *data accessibility*, i. e., over 60% of the available data was referenced to this system; West Kentucky TVA data was readily available in quadrangle form. The time-consuming transfer of Rectangular Grid data to another system was not an objective of the study nor of immediate interest to the Illinois Air Pollution Control Board. Computer programs for converting township data to a national geographic base are available (J. Simon, personal communication 1970) although not all data collected as part of this study is in the form for immediate computer transfer to less than a township level of detail.

Coal reserves in Illinois and Indiana are referenced according to legal plat descriptions and written in terms of the Federal system of rectangular surveys (Figure 4-1).

A system of rectangular survey is divided into surveyor (townships) approximately 36 square miles.

The townships are divided into 36 sections of one mile square or as close to this size and shape as conditions of the survey permit. Sections are further divided into quarter sections. The intersection of a north-south principal meridian and east-west base line establishes the initial point for the survey and provides a point of reference for subdivision of land (Figure 4-2).

Townships are designated according to their positions with respect to the principal meridian base line and are numbered consecutively north and south from the base line, and east and west from the principal meridian or range line. They are therefore identified by a two-digit system, i. e. T (*township*) 4 North - R (*range*) 3 - East. While principal meridian is not referenced in this report, state and county designations permit positive identification of each reserves parcel.

To facilitate data collection using the rectangular grid system in Indiana, the donations¹ and land grants system (see Figure 4-3) has been modified and township designations assigned.

In West Kentucky, the U. S. Geological Survey quadrangles system (Figure 4-4) indexed by name was used for basic geographic reference. TVA numerical designations for named quadrangles were adopted by the IBM study team for reference. Using the Grenville Quadrangle (West Kentucky), computation of quadrangle area was made. This quadrangle was selected because of its central location in the West Kentucky Coalfield. While quadrangles vary slightly in size with changing latitude, an area of 58,936 square miles was determined as representative for the area. An area of 58 square miles was used for reserve computations.

The Carter Grid System was initially assessed for West Kentucky. The Carter Grid System of Kentucky is based on 5-minute area sub-divisions of latitude and longitude -- called townships -- subdivided into 1-minute by 1-minute sections. They are numbered beginning with the number 1 in the northeast corner of an "S" pattern ending with the number 25 in the southwest corner. Tiers of townships are lettered from A to R to the north and numbered from 1 to 42 to the east. The origin is established at 36° 30 minutes N latitude and 89° 30 minutes W latitude; there is no ground monumentation.

While the Carter Grid System had advantages, including a "township" size (30 square miles) compatible with townships (36 square miles), the system was not adopted in Illinois and Indiana because there was relatively little data referenced to the Carter System. A majority of records in the state of Ken-

¹ Donations so named because outright gifts of Federal Government to heads of families residing in Vincennes (or nearby Illinois) area. Areas sub-divided into donations under act of Congress, March 3, 1791 are indicated on index map. Private claims by persons displaced from donation lands are called locations and designated by the letter L. All other numbered grants are assumed to be surveys, prior claims which were ordered to be surveyed by the Act of 1791. Status of unnumbered grants outside major donation and survey tracts is uncertain. Shaded boundaries outline congressional townships and areas sub-divided into donations. Surveys and locations are grouped into congressional townships in conformity with original land survey sheets, which show surveys numbered in sequence within each township. Vincennes Common lots, Lower Prairie surveys, and areas subdivided into donations are arbitrarily grouped. For further information refer to Schneider (1965).

RECTANGULAR
SURVEY SYSTEM
ILLINOIS

TOWNSHIP

RANGE

MERIDIAN

BASE LINE

0 10 20 30 40 miles

Figure 4-1

tucky are filed by reference to quadrangle or in older literature referencing vector direction from geographical point, e g., a town or hill. In addition, TVA reserves data were readily available by quadrangle.

4.2.2 Data Elements

4.2.2.1 Coal Quality and Seam Related Elements

Coal quality data elements were incorporated in this study by seam and selected on the basis of recommendations of the Illinois Air Pollution Control Board and HEW. Figure 4-5 indicates typical level of detail collected for coal analysis by many state and Federal groups, all of which could not have been incorporated into the coal resources data bank.

The final basis for selecting parameters to be addressed in this study was an immediate significance to the Illinois Air Pollution Control Board with respect to air pollution control and planning. Variations within one seam over a small area (Figure 4-6) emphasize the necessity of collecting abundant data so that summaries by unit area are representative. Figure 4-7 summarizes the coal quality and seam-related data incorporated into the coal resources data bank.

For additional coal quality information including range or sulfur or thermal values, the reader is referred to such state reports as Illinois State Geological Survey Bulletin No. 62 or summary printouts available at the Indiana State Geological Survey.

Sulfur

Discussions concerning the various forms of sulfur in coal are included in Walker and Hartner (1966) and Gluskoter and Simon (1968). Sulfur occurs in coal in three chemical arrangements; (1) combined with organic coal substances, (2) combined with iron as pyrite or marcasite and (3) combined with calcium and iron as sulfates. These forms are commonly referred to as organic, pyritic, and sulfate and vary, not only among coal beds, but within a seam (Figure 4-8). Sulfur in the form of sulfate in fresh coals is generally less than 0.1% and not considered critical for this study.

Observed throughout the course of this study was the obvious dearth of statistics on sulfur varieties by seam. Cady (1952) indicated in a study in Illinois that little information was available on the sulfur content of Illinois coals. At the completion of a study by Weir and Company (1965) it was noted that

“ in conducting this study of coal desulfurization, it should be mentioned that one outstanding difficulty arose in that in spite of intensive literature survey, personal contact with numerous departments of government, individual coal companies, and individuals who specialized in working on coal problems and the characteristics of coal in the United States, there is still a great paucity of information on not only the forms of sulfur in many major coal beds of this country, but in the grain and particle size of pyrite.. relatively little work has been done to show the results which can be achieved by fine grinding or crushing of coal. While there appears to be a growing interest in the sulfur content of coal because of projected sulfur emissions,

there has been generally insignificant progress when compared to the total magnitude of the problem.”

Total sulfur statistics are often reported in available literature, but pyritic and organic sulfur data of the quality included in Gluskoter and Simon (1968) or analyses available in the Indiana State Geological Survey are relatively rare. Despite available data, information regarding sulfur distribution in coals of the MWCF is rather limited when compared, for example, to coal thickness statistics.

Pyritic, organic (and total) sulfur data were collected on the dry basis to the nearest 0.1% by seam and by unit area and county. For mapping purposes, data were divided into 0.5% classes from less than 1% sulfur to greater than 4.5% sulfur. The occurrence of pyritic sulfur, presented as the minerals pyrite and marcasite (pyrites), varies widely, and is generally more frequently found at the top and bottom of coal seams. Pyrites may occur in lenses, bands, nodules, joint fillings or as finely disseminated particles. Its distribution pattern will determine the extent to which it can be removed by conventional coal preparation methods. Crushing and available coal-cleaning processes will release most of the pyrite in lenses, bands and joints, but finely disseminated pyrite can only be partially removed with fine crushing. Little data are available by seam as to pyritic sulfur distribution by size or form.

Organic sulfur is distributed throughout the coal as part of its molecular structure and is virtually impossible (by normal cleaning methods) to remove. With increases in total sulfur, both pyritic and organic sulfur tend to increase although there is no direct relationship between the two.

Cleaned sulfur data are collected to the nearest 0.1% by seam, unit area, and county and indicate sulfur remaining after some form of mechanical cleaning. Approximately several hundred reliable clean sulfur values can be identified throughout the MWCF. Because cleaning is dependent upon sulfur form, close scrutiny during mining of variations in sulfur distribution is essential. During combustion it contributes to the formation of boiler deposits that reduce efficiency, and often leads to severe and caustic corrosion problems.

Ash

Ash is a noncombustible residue remaining behind after coal is burned and may represent in part contamination from the roof or floor during mining. Wide variations in ash content -- amounting to 10% or more -- can often be attributed to relatively local variations in clay content largely associated with the original depositional environment of the coal. The amount of ash left behind after coal is burned may approximate original mineral matter. A summary of the major ash constituents of commercial U. S. coals including ash fuseability data are presented by Abernathy, Peterson and Gibson (1969). In bituminous coal, silicon, aluminum, and iron oxides make up about 90% of the ash.

Clay is one of the most prominent impurities in coal. Clay occurs as distinct bands or as vertical partings, and much of this clay can be separated from the coal during crushing and removed by specific gravity methods. Knowledge of the thickness and

	Longitude of Principal Meridian			Latitude of Base Line		
	West From Greenwich			North From the Equator		
SECOND	86°	28'	00"	38°	28'	20"
THIRD	89°	10'	15"	38°	28'	20"
FOURTH	90°	28'	45"	40°	00'	30"

Figure 4-2. Rectangular Grid System principal meridian and base line reference data.

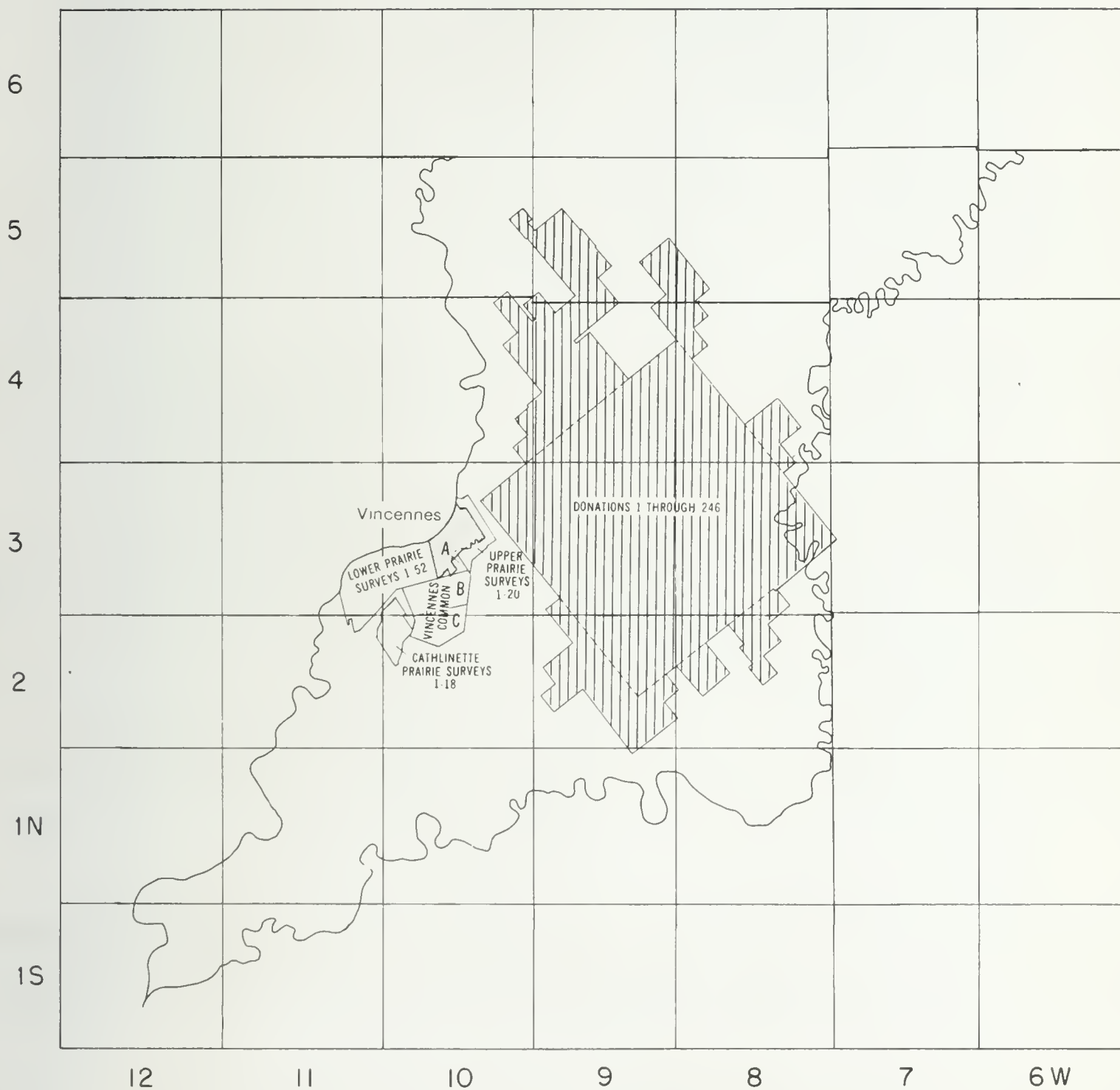
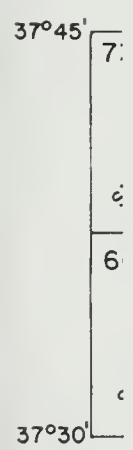


Figure 4-3. Index Map of Knox County showing major donation and survey tracts and township/range designators.

38° 00'



WESTERN KENTUCKY QUADRANGLE

INDEX SHEET

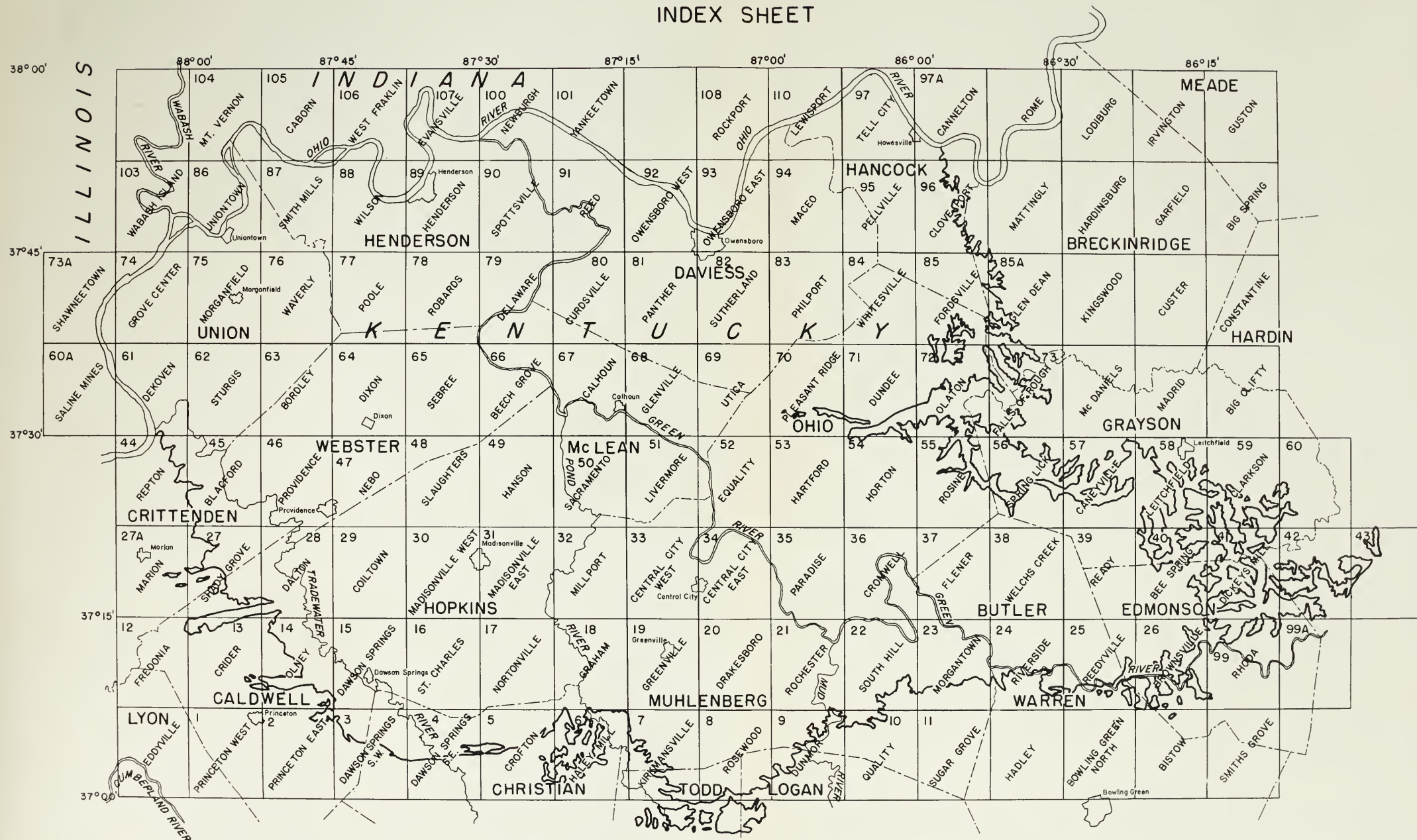


Figure 4-4. Reference map showing Quadrangle names and TVA designators (number) over West Kentucky.

AFTER
TENNESSEE VALLEY AUTHORITY
FUELS PLANNING STAFF

Sample No. _____
Request No. _____
Project _____

ILLINOIS STATE GEOLOGICAL SURVEY
URBANA, ILLINOIS
REPORT OF COAL ANALYSIS

Lab. No. _____
County _____
Index No. _____
Mine, car, or tippie sample _____

Analysis requested by _____
Sample _____
Representing _____ inches _____ tons _____ cars Operator _____
Size _____ Condition _____ Mine _____
Method of sampling _____ Town _____
Sampler _____ Coal bed name _____
Location in mine _____
Thickness of bed _____ inches. Excluded: _____
Thickness in sample _____ inches.
Weight, gross _____ lbs., net _____ lbs.
Date of mine sampling _____ Date of laboratory sampling _____
Date of analysis _____ Date of calorimetry _____
Remarks: _____

COAL ANALYSIS

Air-Dry Loss _____ %		AIR DRIED	AS RECEIVED	MOISTURE FREE	MOIST. AND ASH FREE	UNIT COAL	
						Dry	Moist
Proximate analysis	Moisture			---	---	---	
	Volatile matter						
	Fixed carbon						
	Ash				---	---	---
TOTAL							
Ultimate analysis	Hydrogen						
	Carbon						
	Nitrogen						
	Oxygen						
	Sulfur						
	Ash				---	---	---
TOTAL							
Sulfate sulfur							
Pyritic sulfur							
Organic sulfur							
TOTAL SULFUR							
TOTAL CHLORINE							
Calorific value in Btu per lb.							
Ash fusion: _____ °F		_____ °F	_____ °F	_____ °F	_____ °F		
		Initial Def.	Spherical	Hemispherical	Fluid		

Reported _____, 19____

ANALYTICAL SECTION

Figure 4-5.

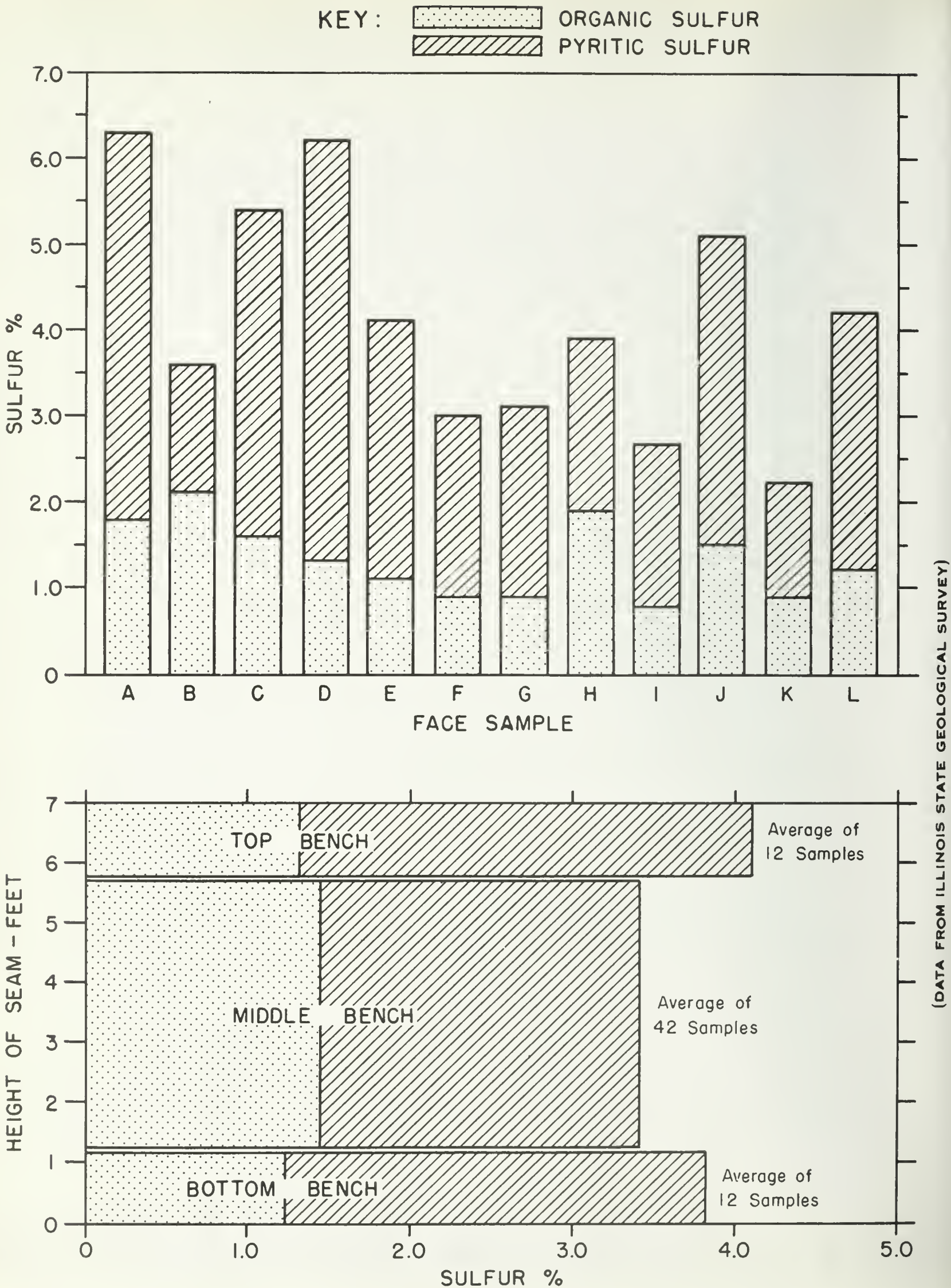
Bench No.	Moisture	Ash	Volatile matter			Fixed carbon	Btu per lb		Sulphur
	As- received (pet.)	dry (pet.)	As- received (pet.)	dry, ash-free (pet.)	Calcu- lated (pet.)	Dry, ash-free (pet.)	As- received (pet.)	Dry, ash-free (pet.)	Dry (pet.)
1.....	1.5	25.4	40.9	51.2	40.0	45.8	10,990	11,530	1.15
2.....	1.7	15.7	37.1	44.7	33.1	53.3	11,330	13,600	10.4
3.....	Pyrite								
4.....	2.0	10.0	39.5	43.7	37.6	56.3	12,700	14,470	0.90
5.....	1.8	3.1	42.5	44.7	41.5	55.3	13,600	14,370	0.97
6.....	1.5	8.5	36.7	40.7	34.3	59.3	12,860	11,230	0.73
7.....	2.1	8.2	37.4	41.6	38.8	53.4	12,710	14,100	0.73
8.....	1.8	12.4	38.7	45.0	38.7	55.0	12,300	14,300	0.81
9.....	1.7	41.7	25.6	47.4	28.9	52.6	7,450	13,710	0.54
10.....	1.7	9.6	39.5	44.5	37.4	55.5	12,750	14,350	0.82
11.....	1.5	25.6	31.5	43.0	33.4	57.0	10,330	14,100	0.53
12.....	1.7	10.7	37.9	43.1	37.8	56.9	12,550	14,290	0.90
13.....	2.4	6.0	35.3	41.8	39.4	58.2	13,260	14,450	0.71
14.....	1.9	12.5	36.5	42.5	38.2	57.5	12,210	14,210	0.59
15.....	1.6	9.8	36.7	41.5	38.2	58.5	12,720	14,360	1.31
16.....	1.7	16.8	35.5	44.6	36.7	55.4	11,620	14,190	0.60
17.....	2.0	9.2	37.1	41.9	37.3	58.1	12,870	14,490	0.60
18.....	2.3	8.1	36.8	41.0	35.0	59.0	12,970	14,450	0.64
19.....	2.2	5.8	37.2	40.4	37.6	59.6	13,270	14,410	0.65
20.....	1.8	31.8	28.3	42.2	29.4	57.8	9,410	14,050	0.67
21.....	2.0	6.0	39.2	42.6	39.7	57.4	13,360	14,510	0.61
22.....	1.9	4.3	35.0	35.3	?	61.7	13,570	14,450	0.60
23.....	2.4	2.7	39.1	41.2	40.1	58.8	13,690	14,410	0.62
24.....	2.0	8.6	37.5	42.1	41.5	57.9	12,670	14,140	0.57
25.....	2.2	5.2	37.9	41.1	38.6	58.9	13,140	14,250	0.51
26.....	2.5	4.1	39.3	42.0	?	58.0	13,420	14,360	0.69
27.....	2.4	10.0	39.1	44.6	38.8	55.4	9,940	11,310	0.56
28.....	2.6	6.2	37.9	41.6	39.7	58.4	13,170	14,410	0.67
29.....	3.3	1.6	56.2	38.0	?	62.0	13,690	14,370	0.66
30.....	2.7	3.4	39.4	42.0	39.8	58.9	13,600	14,470	0.69
Mean.....	2.0	11.2	37.1	42.8	37.5	57.2	12,390	14,190	*1.05

Figure 4-6. Variations in Coal Quality Within a Seam.
Chemical analysis data for Indiana coal IV after
Neavel, 1961.

DATA ELEMENTS	BASIS	UNIT AREA RECORD	COUNTY RECORD	PROBABLE ACCURACY
ASH	Dry	_____	Nearest Whole Percent	$\pm 1\%$
ASH SOFTENING TEMPERATURE (AST)	At Fusion	_____	Range of Values - Degrees Fahrenheit	$\pm 10^{\circ} \text{ F}$
FREE SWELLING INDEX (FSI)	_____	_____	Nearest Half Unit	$\pm \frac{1}{2}$ Unit
SULFUR	Dry	Weighted Average - Nearest One-Tenth Percent	Range of Values - Tenths of Percent	$\pm 0.2\%$
THERMAL VALUE (BTU's)	As Received	_____	Range of Values - Nearest 100 BTU's	$\pm 200 \text{ BTU's}$
<u>SEAM</u>				
DEPTH OF OVERBURDEN	_____	Weighted Average - Nearest One Foot	_____	$\pm 10 \text{ Feet}$
SEAM THICKNESS	_____	Weighted Average - Nearest One Inch	Range of Values - Nearest One Inch	$\pm 1 \text{ Inch}$

Figure 4-7

Summary of elements recorded on unit area and county data sheets. The accuracy of values into the resources data bank are indicated at the far right.



spacing of clay bands may aid in determining crushing size fractions to obtain the lowest ash product. Total ash content was recorded by seam and county on a moisture-free (dry) basis. The ash content of coal beds in the MWCF varies greatly over large areas.

Knowledge of the composition of coal ash may be helpful in predicting slagging characteristics in combustion. Ash content is of particular interest to industry because of the heating losses incident to the presence of ash. Furthermore, coal handling costs increase because of the expense of disposing of ash.

The average ash content of all coals by state is summarized for reference in Figure 4-9.

Thermal Values

The assignment of thermal value (expressed in BTU's per pound) was made on an as-received basis by seam and county.

Many industries (and specifically utilities) make coal purchases based on thermal value and their as-received determination of this value serves as a basis for price adjustment.

The average thermal value of coals for Illinois, Indiana and Western Kentucky are 11,729, 10,620, and 12,096 BTU's/lb., based on analysis of data collected in this study. Sheridan (1968) estimated that on the basis of as-received analyses, overall thermal value of the western Kentucky coals approximated 11,970 BTU's per pound.

Free Swelling Index (FSI)

The free swelling index is one measure of the cokeability of the coal. It is recorded in numbers from ½ to 9 and summarized by seam and county. The higher indices are those of greatest interest to the steel industry, i.e., the higher the free swelling index, the better the coke produced. Free swelling indices vary from 1 to 2 in northern Illinois and from 3 to 4 in southern Illinois.

Ash Softening Temperature (AST)

Ash softening or ash fuseability temperature was recorded by seam and county in °F. AST values were added to the data bank since knowledge of ash fuseability is critical in boiler design to insure proper disposal of slag materials. AST data, like ash, impact the design of steam plants as well as hydrogenation and gasification facilities.

4.2.2.2 Seam Parameters

Seam Thickness

Seam thickness is expressed to the nearest one inch for unit area and county. The average seam thickness of the coal over a unit area was estimated from isopach (lines of equal thickness) maps for that seam wherever possible. Ranges of thickness data are, however, controlled in part by availability of sulfur data. While an attempt was made to gather as much thickness data as possible, minimum and maximum thickness values most often represent thickness data where the coal was mined. As such, a minimum thickness of zero, i.e., coal not present,

was not recorded. For purpose of this report, coals less than 24 inches thick are designated as thin coals, 24 to 48 inches as intermediate coals, and greater than 48 inches as thick coals.

Coal seam thickness variations are directly related to differences in the rates of accumulation and preservation of original plant material, the depositional surface and presence of ancient stream channels which may have eroded the seam. In some areas, e.g., in Posey County, Indiana, variations in coal seam thickness may be principally related to difficulty in correlating seams in the subsurface using a limited number of drill holes and geophysical logs. Coal thicknesses in this report do not include partings (often in excess of 15 inches) which split seams into two or more parts. In Greene County, Indiana, for example, Coal III was separated by a parting of 40 inches.

Thickness statistics were particularly abundant in mined areas, and may reflect thick coal only; in many instances mining was terminated because of a thinning of the seam, but detailed records are unavailable.

Thickness of the coal seam is one of the more important factors influencing coal recoverability. The relationship of the percentage of bituminous coal mined by state with relationship to thickness seams is summarized in Figure 4-10.

Thickness of Overburden

Thickness of overburden (depth to coal) has been determined by unit area to the nearest one foot. For major coals, at least 10 determinations of overburden thickness per unit area were made where practical. Overburden figures were grouped by unit area and county and weighted to yield a mean value.

Geological analysis of cross sections combined with topographic information and known seam depth provided a basic source of data. Particular difficulty in calculating thickness of overburden was experienced where coals were lenticular, discontinuous or otherwise poorly known. Thickness of overburden (and seam thickness) data were obtained from analysis of mine records and drill hole records at the Indiana and Illinois State Geological Surveys. In West Kentucky, drill hole records were largely used.

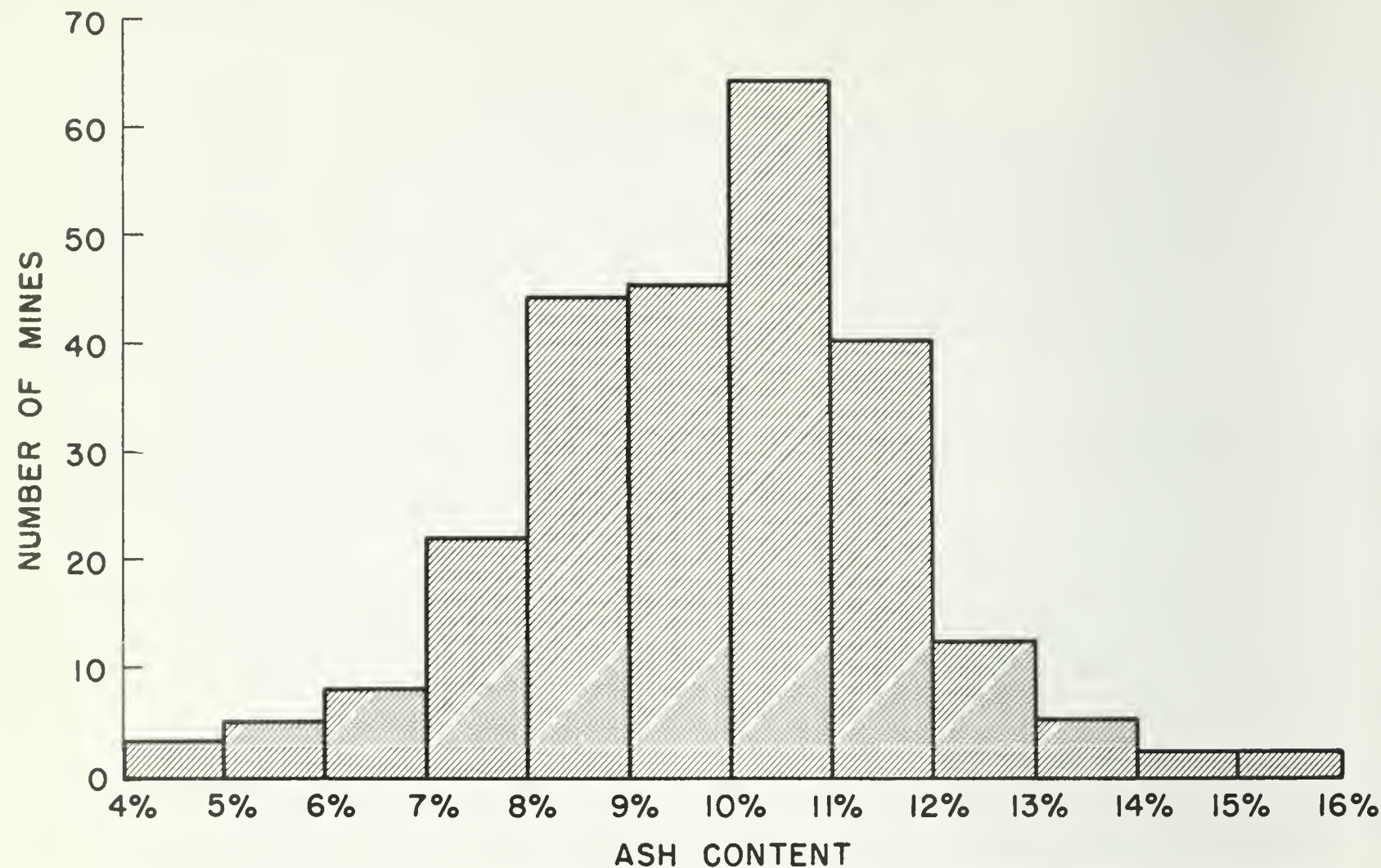
Coal seams less than 150 feet beneath the surface, were judged suitable for strip mining.² It is presumed that extraction of coals greater than 150 feet in depth would require underground methods unless local topographic conditions encouraged auger mining.

The maximum thickness of overburden which will be stripped will be determined by such factors as grade of coal, coal thickness, overburden lithology, accessibility to markets and a variety of economic factors.

Established trends (Figure 4-11) indicate increasing stripping depths as techniques improve, and as shallow coal reserves are exhausted.

² Increase in the size and efficiency of strip mining machinery has permitted a steady increase in the average maximum thickness of overburden that can be removed. A drag line system built by Bucyrus-Erie Company can dig to a maximum depth of 185 feet. This suggests that stripping to a depth of 150 feet is not only feasible but may be practical with existing equipment.

AVERAGE ASH CONTENT OF FACE SAMPLES OF ILLINOIS COALS



NOTE: Ash content of West Kentucky coals average 9-10%. (Sheridan, 1968)

Figure 4-9. Average ash content for face samples of Illinois Coal, as computed from Illinois Geological Survey data. Average ash content determined from study data are 10.8% (Illinois), 14.5% (Indiana) and 8.55% (West Kentucky). Sheridan (1968) estimated that the ash content of West Kentucky Coals average 9.10%.

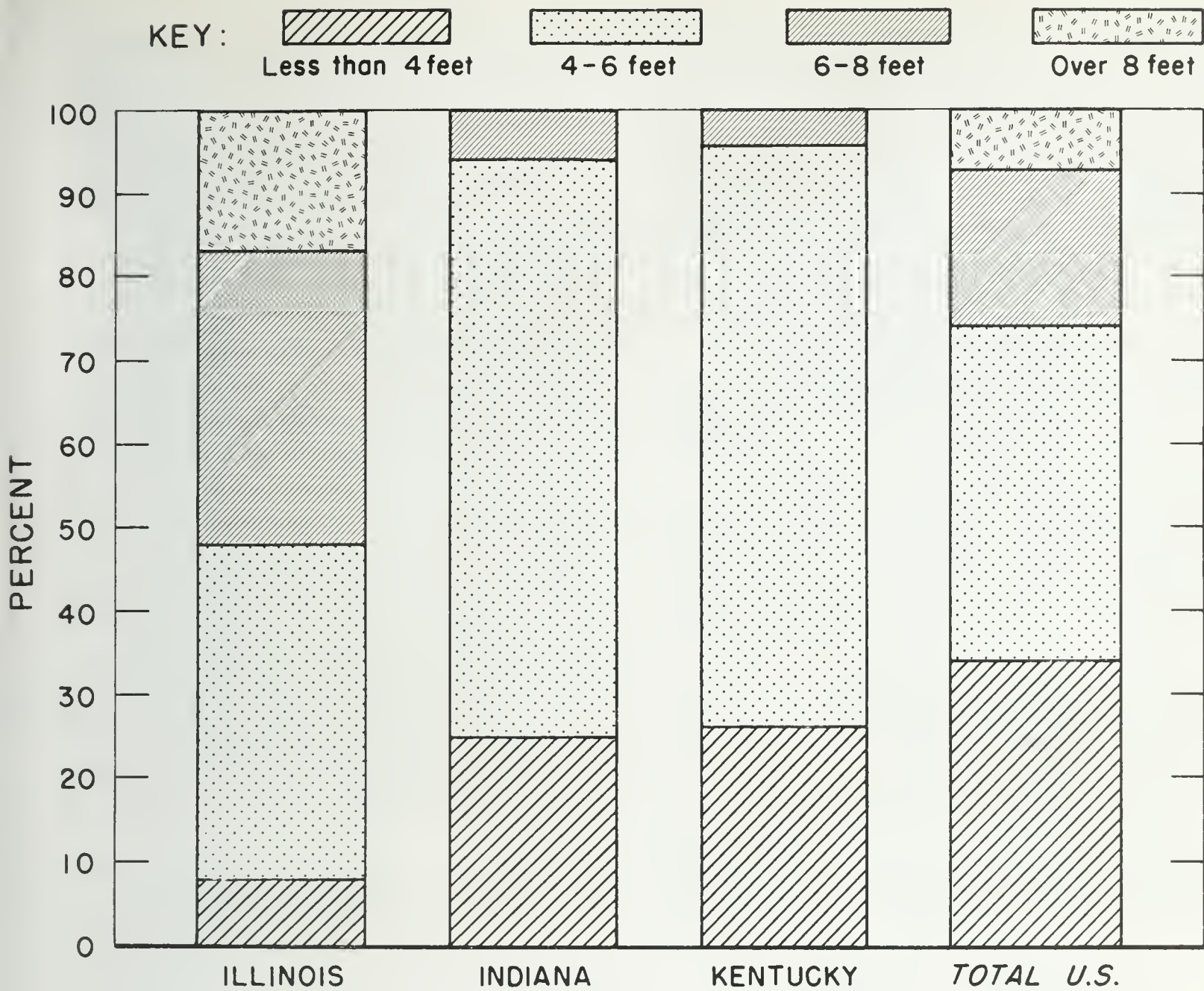


Figure 4-10. Percentage of bituminous coal mined in the MWCF versus seam thickness. (From YOUNG, 1970)

	1946	1950	1955	1960	1965
Average thickness of overburden removal	32	30	42	46	50
Maximum thickness of overburden removed	---	---	70+	100	125
Average thickness of coal recovered	5.2	5.1	4.9	5.1	5.2
Ratio of average overburden thickness to average coal thickness	6:1	8:1	8.5:1	9:1	10:1

Figure 4-11 Average thickness (in feet) of overburden removed versus bituminous coal and lignite recovered by strip mining in the United States for selected years, after Averitt (1968).

Categories of depth of overburden information vary from state to state and between agencies. Anticipating a trend toward greater stripping depth, the Illinois and Indiana Geological Surveys, have been outlining areas suitable for strip mining with overburden thicknesses as great as 150 feet. Relatively little deep coal reserves have been mapped below 1,000 feet in the MWCF (Figure 4-12).

As a general procedure for determining thickness of overburden, unit areas boundaries were plotted on a structural contour map (showing elevation at the top of the coal seam with respect to a sea level datum). An arbitrarily chosen grid was plotted on topographic maps and a proportionate grid then plotted on structural contour maps. At grid intersections, calculations were made and thickness of overburden with respect to the seam determined. For example, if the topographic elevation of a selected point was determined to be 500 feet above sea level, and the top of the coal seam was 200 feet above sea level, then the overburden value at this point would be 300 feet. With information on coal elevation available for a variety of persistent and relatively identifiable coal seams and other beds, it was possible to develop elevation information for less persistent seams.

Reliable data on thickness of overburden for coals not actively mined could also be determined by using isolated drill holes which may have penetrated the minor coals. In many instances, discontinuous or lenticular coal overburden data are approximations determined by literature citations, coal elevations and outcrops at isolated and scattered localities.

4.2.3. Reserves Computation

Determination of Coal Reserves in Place

Coal reserves estimates (expressed in short tons) are based upon a combination of geological observations after mapping, exploratory drilling and geological judgements. Established procedures for reserves evaluation are relatively well documented, and basically involve the determination of the volume and weight of coal.

The procedure for reserves estimates is well established. A given area, with given thickness of coal to determine volume, is multiplied by a weight factor to compute reserves. Simply expressed,

$$CR = A \times t \times k_t$$

A = area, in acres or square miles

t = seam thickness in feet

k_t = constant of 1800 tons per acre/foot or
1,152,000 tons per sq. mile/foot of coal
(at 1.32 specific gravity.)

The broad procedure for determining available coal reserves involved: (1) determination of unit area and mean seam thickness, (2) computation of original reserves, (3) evaluation of mined out areas and areas most probably lost to mining, (4) computation of remaining reserves in place, and (5) computation of available reserves (by applying a recoverability factor for strip and deep mining operations, and several geologically-related assumptions.

To insure the accuracy of reserve estimates

using area mean thickness, several tests were conducted to determine whether a method of seam thickness approximation could prove comparable to results obtained using the more lengthy detailed mapping. Tests conducted involved comparison of results from detailed maps (and reserves estimates) and those obtained using mean thickness. Thinning and thickening, as well as the lenticular character of some coal seams introduced reserves overestimation amounting to 10 to 12 percent in this study. When several subjects tested the study procedure in relatively complex geological areas, overestimates varying from 5 to 15 percent were experienced.

The factor designated CLG (coal left in the ground) was used to designate the reserves remaining after areas considered lost to mining are eliminated. CLG data are summarized on CLG-map (see pocket).

A CLG factor of 1.00 indicates that, based on all available data, reserves were present and could probably be mined. Subsequent re-evaluation of deposits in light of changing technology is probable, and hence "lost" has a less permanent connotation than otherwise expected. Detailed assessment of losses attendant in mining cannot, in fact, be determined before extraction.

In addition to geological considerations, attention has been given the factors associated with mine safety. In view of new legislation, activities previously acceptable as general mining practices, may be eliminated in the next several years to guarantee the safety of surface structures or of mine personnel.

The CLG factor takes into account significant effects which have long term implications to reserves exploitation. Factors including the effects of pipeline and highway right-of-ways on reserves availability could not be analyzed in detail within the time limitations of the study.

Thin or Absent

There are approximately fifty coal horizons over the MWCF, but probably no more than half are sufficiently thick to be regarded as important resources. Cady (1952) considered seams with thickness less than 28 inches as not practically mineable. He suggested that if a thin coal limit of 14 inches were included in coal reserves estimates, a reserves increase approximating 37 billion tons would result in Illinois.

Thin coals which are fairly continuous or relatively thick lenticular coals are currently being profitably mined. Thin coal beds -- especially where several thin seams occur close together -- are now being strip mined in West Kentucky. Reserves were not computed for seams less than 24 inches, although data concerning sulfur content and other terms of analysis were recorded.

Mined Out Areas

Basic to the problem of determining remaining coal reserves is computation of tonnage removed by mining. Mined out area maps were largely obtained from state geological survey compilations rather than from central depositories of mine maps usually filed in various state mines departments. Production fig-



Figure 4-12. Outline of the area in Illinois where the No. 6 coal is 1000 feet or more in depth beneath the surface. (from CADY, 1952).

ures were used to estimate remaining reserves in some areas where mine maps were unavailable.

Since the preparation of Illinois reserves estimates by Cady (1952), the State of Illinois has maintained updated mined out area maps (Figure 4-13). Draft copies were made available for this report. TVA geologists have recorded mined out areas on 7½ foot quadrangle maps over western Kentucky which served as the basis for estimate there. In Indiana, mined out area maps were referenced in several state departments.

Interviews with geologists and mining engineers familiar with some mining ventures permitted rough updating of mined out areas when other data were unavailable. In some instances, comparison between several data sources revealed apparently erroneous data particularly regarding shape or location of mined out regions which were resulted wherever possible.

Channel Cutouts

In many areas, ancient streams eroded portions of coal seams following deposition. These stream channels have, in some parts of Illinois, (e.g., Bond, Montgomery, and Washington counties), cut through and removed significant quantities of coal. These channel sandstone areas were eliminated from reserves. Coal eroded by glacial action was also included within this category.

Heavily Drilled Areas

Closely spaced oil and gas wells in some areas limit coal recoverability. State oil and gas development maps were updated to reflect recent activity. Private sources, e.g., H. E. Keller and Company (Kentucky) and Scout Check (Indiana) data supplemented state sources. Heavily drilled areas have been conservatively outlined and are summarized on the CLG Map. (See pocket).

Areas heavily drilled for oil and gas will probably not be mined for many years, if at all. Besides the necessity of leaving large blocks of coal around drill holes, inadequate plugging of drill-holes generates technical difficulties, e.g., gas and water leaks which preclude safe mining.

In many areas, hundreds of acres have been made unmineable (with present technology) because of the high density of oil drilling. Oil and gas drilling planned in close cooperation with oil and coal companies, e.g., the TVA's Camp Breckenridge area in West Kentucky, can be mined. In areas of active mining where elaborate precautions to protect coal beds against invasion by oil, gas or water, e.g., in the Franklin County area of Illinois, were taken, coal was not excluded from available reserves.

Drilling density of one well per five to 10 acres is generally considered a region of heavy drilling. Most oil production wells are developed on an approximate 10 acre grid spacing. Where oil and gas well spacing is from 500 to 1,500 feet, the amount of recoverable coal will be greatly reduced because of barrier pillars which must remain around these wells if the coal is mined.

Gas Storage Areas

For purposes of this study, gas storage areas

underlying coal-bearing sediments are considered hazardous to mining operations and reserves estimates were deleted over such areas. With the help of available maps and supporting (unpublished) file data, underground gas storage areas were separately mapped from areas heavily drilled for oil and gas. Background data containing the nature of underground gas storage reservoirs may be obtained by referencing Buschback and Bond (1967) and Thomas (1968).

Water Bodies

Consultations with the Illinois State Geological Survey (J. Simon, personal communication, 1969) suggested that all areas beneath rivers should not be considered lost to mining because successful coal mining operations have occurred under the Wabash, Illinois and other rivers. Furthermore, mining is in progress beneath the river at the Muhlenberg-Hopkins County line, West Kentucky.

Areas beneath large water bodies, e.g., lakes or reservoirs, were not, therefore, eliminated from reserves estimates. River flood plain deposits may lie directly on or close to coal seams, thus limiting their mining or increasing risks to safety. During the period of this study, Federal legislation has been enacted requiring that entries under any river, stream, lake or any other body of water include appropriate precautions to assure a minimum safe rock cover against cave-ins and other hazards.

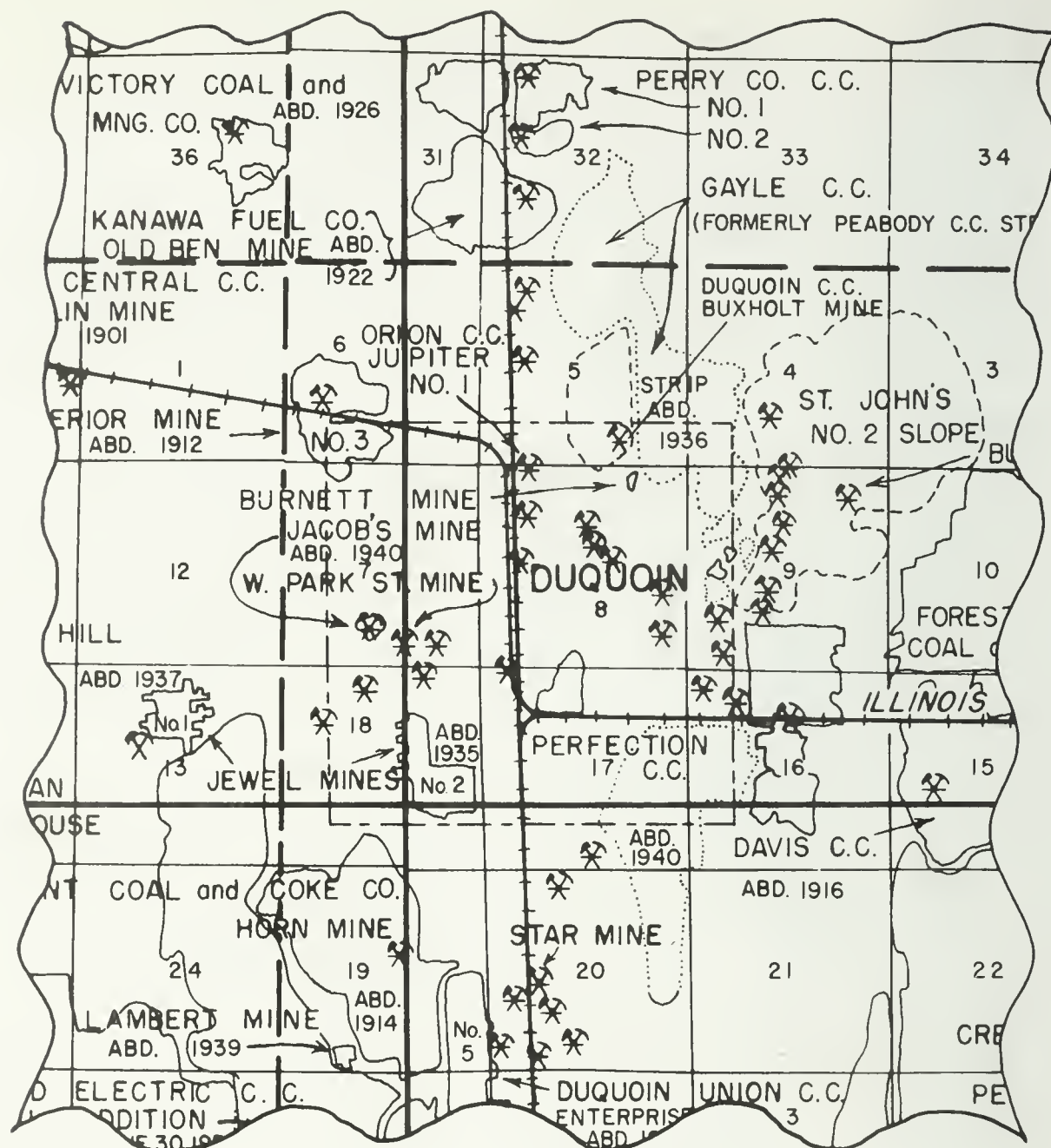
Faulting

Faulting not only introduces a mining inconvenience, but -- in the case of closely spaced faults -- can limit exploitation of remaining reserves. Coal preserved in small pockets between faults may not only be difficult to mine, but may present serious safety hazards with the possibility of rock falls or introduction of quantities of ground water.

The geological map of Illinois (Willman, et al, 1967) contains the most recent summary of faults in the state of Illinois. Even in the areas of closely spaced faults, the coal had been mined out in many instances. Data included in Stonehouse and Wilson (1955), Harrison (1951) and DuBo (1961) suggest that faulting does not limit coal mining in southern Illinois. In Indiana it is rare for displacement to exceed the thickness of the coal bed, except in the southwest corner of the state. Data available, therefore, indicates that relatively few faults limit the mining in Indiana or Illinois.

The structure of the west Kentucky coal field is, however, dominated by the Rough Creek Fault Zone which divides the area into a northern and southern section. Mullens (1966) described the structure of western Kentucky and the interested reader is referred to this reference for details. Areas immediately adjacent to major faults were excluded for approximately one hundred feet across major faults with special exclusions made for small remaining coal sandwiched between closely spaced faults series in West Kentucky.

The rationale for eliminating areas of coal near faults is based on reports in western Kentucky which indicate that considerable difficulty was experienced in mining the No. 9 coal. Roof support was difficult



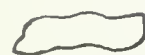




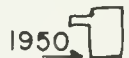
- | | | | |
|---|------------------------------|---|-------------------------------|
|  | Mined-out area (underground) |  | Mine tripple site (active) |
|  | Mined-out area (strip) |  | Mine tripple site (abandoned) |
|  | Indefinite mined-out area |  | Date of mine map extension |

Figure 4-15 (From Mined-Out Area map, Illinois State Geological Survey)

Illinois State Geological Survey Class	Maximum distance from datum points*	Accepted datum points	U.S. Geological Survey	Illinois Coal Study
I-A Proved	1 1/2 mile	Mined-out areas Diamond Drill Holes Outcrops	Approximately equivalent to "measured" category of the U.S. Geol. Survey	Assured
I-B Probable	2 miles	All points of Class I-A plus coal test churn drill holes	Approximately equivalent to "indicated" category of the U.S. Geol. Survey	
II-A Strongly Indicated	4 miles	All points of Classes I-A and I-B plus churn drill holes drilled for oil or water with unusually good records and control rotary drill holes.	Approximately equivalent to "inferred" category of the U.S. Geol. Survey	
II-B Weakly Indicated	Indefinite	All points used in higher categories plus knowledge of geologic probability based on all available information	No equivalent	Implied
(No Equivalent)	Data very limited or weak extrapolated up to 6 miles using reasonable geological judgement	As all points above, with analysis of county, township or quadrangle data.		

Figure 4-14 Classification for coal reserves inventory as used by Illinois State Geological Survey, (from Cady, 1952). Approximately equivalent U.S. Geological Survey categories are listed. Illinois Coal Study approximate confidence designations are shown at the far right.

when mining paralleled faults. In some instances, mining at right angles through faulting eliminated the problem. TVA has indicated that in the Morganfield Quadrangle, the No. 9 coal is considered unmineable within the Rough Creek Fault Zone.

The complexity introduced by faulting in west Kentucky is illustrated in the southern portion of the Coiltown and Dalton quadrangles, where displacements range from a few feet to 550 feet. In one location, No. 11 and No. 4 (Dawsons Spring) coal are mined together in the same level across a fault.

Pipeline and Highway Right-of-Way

Analysis of available oil and gas industry and state geological survey oil and gas maps reveal an extensive network of oil and gas transmission pipelines. Legal prohibitions against mining in the vicinity of or under pipelines will certainly reduce the availability of reserves in these areas.

Furthermore, interstate highway systems cover several hundred square miles of the MWCF and a relatively large area is therefore generally unavailable for underground mining. Prohibitions against mining to insure the security of the highway rights-of-way in the interstate highways or pipeline rights-of-way has contributed to reduced recoverability in some areas, although these factors have not been evaluated in detail.

It has been estimated that there are 900 miles of interstate highways over the MWCF with rights-of-way approximately 300 feet in width; or something less than 50 square miles of coal lost to mining.

A rough estimate based on American Petroleum Institute data suggests that there is approximately 12,000 miles of pipeline overlying coal deposits in Illinois which can eliminate over 200 square miles of coal assuming a 100 foot wide right-of-way.

Intrusives

Intrusive bodies which cut through coal seams occur in some areas of southern Illinois. Intrusives have also been detected during drilling; and baking of adjacent coal in areas of intrusives has been reported in western Kentucky. None of these have sufficient areal extent to limit reserves significantly.

Under towns (urban areas)

All coals lying beneath major population centers, regardless of depth, were excluded from remaining reserves. While it is recognized that deep underground mining might not affect surface areas, and therefore, constitute little hazard, increasingly stringent attitudes toward mine safety suggest that mining beneath towns may be banned or severely curtailed in the next ten years.

Urban areas shown on the CLG maps are those indicated (in yellow) on USGS 1:250,000 topographic maps.³ Town boundaries were modified according to latest highway maps of the Illinois State Highway Department, including city supplements, where substantial growth was noted.

In addition to excluding coals directly under towns, areas underlying large industrial sites have been excluded where it was known that the coal beneath was purchased as a safety precaution to protect surface structures.

4.2.3.1 Confidence Levels of Estimates

Reserves estimates in this study have been categorized by the terms "assured" (A) and "implied" (I). This classification terminology is contrasted with that used by state geological surveys and the Federal government (Figure 4-14). The assured category generally applies to all data developed by state or Federal geological agencies. The implied category is characterized by extrapolation of geological data more liberally than in previous studies.

To extrapolate data from known points (assured values) to implied values required analysis based on regional geology or the character of the coal seam, floor or roof rock, position and type of partings, and conspicuous stratigraphic intervals. With increasing distance from data points, the reliability of such extrapolation rapidly decreases. Where data was very limited by detailed mapping standards, extrapolation was limited to 6 miles (or approximately 1 township).

Recoverability

Recoverability is a significant consideration in the assessment of coal reserves. Underground mining operations in various parts of the United States have a recovery expectation generally estimated to be 50% of reserves in place, although in reality, recovery varies among mines (Figure 4-15).

Geologically-related factors which affect coal recovery in deep (underground) mining operations may be summarized as follows:

Mining methods -- For underground operations, no-pillaring, partial pillaring or full pillaring affect recovery. For strip operations, the extent to which automated equipment is used (the size of the mining operation) affects recoverability.

Roof conditions -- Relatively hard sandstone roof rocks result in a higher recovery than soft shale roofs. Roof rock, regardless of character, which is highly fractured or subject to falls because of rapid thickening and thinning reduces recoverability.

Floor conditions -- Soft rock underlying the coal seam reduces recoverability.

Potential of surface subsidence -- With increasing emphasis on safety in mining operations, the need to leave additional pillars for roof support will negatively affect recoverability.

Character of coal bed -- Variations in the seam such as rolls or undulations, clay veins and partings, faulting or stream channel cutouts reduce the coal seam continuity and, therefore, recoverability.

A historical review of underground coal-mining recovery percentages is included in Lawrie (1969).

³ Burlington 1958, Peoria 1958, Danville 1953-65, Quincy 1944, Decatur 1958, Indianapolis 1953-64, Saint Louis 1945, Belleville 1958, Vincennes 1956, Paducah 1948 and Evansville 1957.

He suggests that recoverable reserves for underground mining averages $57.0 \pm 1.7\%$ (at 95% confidence limits). The 57% recoverage figure is based on recovery from individual mines throughout the United States and does not take into account such factors as the coal left between adjacent workings which would reduce the 57% value. A general recoverability factor of 50% has been used by the Illinois State Geological Survey (J. Simon, personal communication 1969).

Although a 50% recovery factor seems well established for underground mining, strip mining recovery is commonly considered to approach 80%. This 80% figure does not, however, take into account areas between adjacent surface mining operations. During this study, a brief evaluation was made of the Grundy-Will county area, Illinois. It was concluded that approximately 30% of otherwise strippable coal was lost in the course of mining operations. To maintain a conservative estimate of surface mining recoverability, a 70% recoverability value was established.

4.2.4 Data Collection

Data Availability

Few reserves data were obtained from producers. Producer response in terms of total regional production approached 75%, but the relationship between reserves dedicated to long-term customers and reserve ownership is not known. The difficulty of collecting producer data was directly related to the commercial value (or the implied competitive advantage) placed on the data by the producer.

Substantial quantities of coal company data were not available for this study. Little effort was made to completely canvas coal company's files for all type of geological data except by the use of questionnaires.

Reserves and coal quality data, unavailable from published sources, were provided with the cooperation of Midwest Coal Producers Institute. Some of the information provided was confidential, and in these cases, has been used only to confirm data available from open sources.

Analytical data from open sources was old and often reflected coal long since removed. A majority of data available in the areas of active mining are for thick coals less than 1,000 feet deep. These are relatively few deep coal tests available throughout the MWCF, and oil test records often give little attention to presence of a coal seam or its thickness.

Data Conversion

A significant study problem was the massive manual task of reducing large volumes of scattered statistical data into a common geographical base. By conservative estimate, several million data elements were collected, organized into approximately 20,000 data sheets, and reduced following geological analysis to punched cards for machine manipulation. Geographic location proved a particularly troublesome problem in areas where hundreds of small mines may have operated in a single county. In such circumstances, it was first necessary to locate a mine or sample point and, having converted it to the study's geographical base, enter the data for use.

This problem was especially acute in western Kentucky where, for example, it was noted that over the past 70 years some 800 different mines had operated in Hopkins County. Many of these were relatively small operations, often in the same area but mined by a variety of operators under several mine names. While attempts were made to locate such mines and this coal quality data, it was often difficult to reconcile the desire for completeness and accuracy with the extensive time required to trace relatively small company operations.

Data Analysis

An effort was made to balance out specific sample unknowns by collecting large quantities of basic data. For purposes of this study, it was assumed that all state and Federal samples in the post-1910 period were analyzed according to the standard methods of the American Society for Testing Materials. Cady (1952) indicated that the classification of a coal bed in any locality should be based on ".....the average analysis of not less than 3 and preferably five or more face samples taken in different and uniformly distributable localities, either within the same mine or closely adjacent mines representing a continuous and compact area not greater than approximately 4 square miles in its regions of geological uniformity". He further wrote that in regions where conditions indicate, the coal probably varies rapidly in short distances, ample spacing and grouping of analysis to provide average values was to be encouraged.

Data collection and analysis problems comparable to those encountered in this study were experienced by the U. S. Bureau of Mines who recognized the inherent difficulties associated with making such estimates, primarily because of the limitations of basic data including:

- Variations in sulfur content within a coal bed, even within a single mine;

- Lack of basic information on reserves in some geographical areas;

- Lack of recent analyses; i.e., old analyses which reflect the quality of coal long since removed;

- Lack of data on the composition of coal in place. A large proportion of the samples was not representative of the coal as mined, but as "tipple and delivered samples", i.e., coal as loaded into railroad cars and which may have been subjected to some cleaning process.

Sample type is critical in weighting the value of quality data. Face channel samples (samples taken along a coal face and mixed during sampling) which establish bulk composition of the coal beds are perhaps the most representative for purposes of low sulfur reserves analysis. Such samples have been collected by most state geological surveys, although too few of these high quality records are available.

Tipple samples (coal collected at the mine tipple as it is loaded into railway cars and trucks) provide a reasonably representative sample of coal to be delivered to the purchaser. It is, however, sometimes difficult to determine if tipple samples represent raw or cleaned coal, and, therefore, difficult to interpret the data.

TYPE	PERCENT
Unavailable coal	1.8
Oil and gas wells	.3
Property boundaries	.7
Surface features	.6
Other reservations	.2
Economic-technological losses	10.5
Roof or coal, geological limitation	4.4
Haulageway and miscellaneous	4.4
Top coal	1.5
Bottom coal	.2
Unmeasured losses	30.7
Total losses	43.0

Figure 4-15 Distribution of coal losses showing types of losses experienced in underground mining operations (from Lawrie, 1969). Percentage values represent average losses for 200 mines sampled.

Block or hand samples are of local value, and in many areas represented the only available data on their coals. There was often no way to determine the extent of weathering, and hence chemical change.

It is, of course, impossible to determine the extent to which storage may have altered coal properties. For example, shipments of coal in open coal cars or coal stored for long periods at the mine could vary because of the loss or addition of moisture.

Problems involving data analysis largely originated from variations in sources, in sample type, and the method of collection.

It was observed, for example, that some operators in West Kentucky were unintentionally mining more than a single seam of coal and reporting it as a single seam. Mines crossing faults have reportedly extracted several coals in juxtaposition. Mining in the vicinity of Dawson Springs, West Kentucky resulted in mixing of coals from the No. 9 and No. 4 seams across faults, with the change not noted for a period of several days.

Careful consideration of the source of a sample and normal conditions related to its collection were an integral part of the geological analysis. A consideration in using analytical data from producer sources for example, was the fact that samples supplied to commercial testing groups sometimes contain a few inches of rock above or below the coal to stimulate actual mining conditions. Frequently, coal companies include clay bands in the sample collected

companies include clay bands in the sample collected. Such procedures artificially increased the ash (and probably the sulfur content) and made comparisons between face channels and company data difficult. Comparisons between face channel samples taken to U. S. Bureau of Mines Standards and company supplied data suggest a somewhat higher ash content for company data, because the Bureau of Mines method excludes 3/8 inch mineral bands.

Other problems related to sampling which complicate the interpretation of coal quality data include natural coal seam variations. For example, variations in sulfur or ash content can be caused locally by the ancient depositional environment. Local increases are possible in ash content, for example, in the proximity of contemporaneous stream channels. Additional information regarding sample site would have been most helpful in the study's analysis.

Seam correlation difficulties were also experienced because of natural seam variations. Reliability of overburden thickness data, for example, was dependent in some areas on the ability to correlate coal seams. Under some environmental conditions, e.g., deposition in stream channels, small swamps, stream flood plains and shallow lakes, coal accumulated in thin, irregular and isolated lenses.

These features, compounded by faulting and erosion, leave fragmentary records which complicate accurate correlation.

For these reasons, it is quite difficult to accurately correlate in the subsurface and seams based on depth alone. Miscorrelation of coal seams can, therefore, lead to significant errors in thickness of overburden determinations, or coal quality assignments.

4.3 DATA COLLECTION METHODOLOGY

4.3.1 Introduction

The general procedural approach (Figure 4-16) used to develop the coal resources data bank is summarized below. The basic information for the data bank was gathered from questionnaires to producers and analysis of open sources.

4.3.2 Preliminary Program Planning

A procedural summary of this phase is shown in Figure 4-17. The early part of the study was devoted to discussions with principal authorities (Figure 4-18) of the MWCF and evaluating state and Federal data. Basic reference material, including key publications and maps were assembled.

Suitable working materials were developed to facilitate data formatting for analysis. Early in the study a geographic reference system was developed for data indexing. The Rectangular Grid system was chosen for use in Illinois and Indiana, and quadrangle designations used in west Kentucky. To facilitate summarizing coal quality data over a large area, a map scale of approximately 1:500,000 was adopted.

A map (designated CLG map) showing areas of potential but unexploitable, coal reserves was prepared. This map depicted areas of heavy drilling, faulting, etc. Mined-out area maps were developed and updated as necessary. After stratigraphic analysis, coal seam correlation charts to reflect the relative distribution of coal by state and a depth were prepared. Data control procedures to insure the security of confidential data obtained from producers were established.

Two versions of a questionnaire to producers were designed, one in close cooperation with the systems analyst and the other with the advice and counsel of state geological groups and Midwest Coal Producers Institute. Data sheets upon which basic county and unit area statistical data might be collected, were prepared. The county data sheet was intended largely to summarize reconnaissance information by seam. The unit area (townships or quadrangle) data sheet gave primary emphasis to collecting data essential for estimating reserves and detailing sulfur content. To insure proper evaluation of various data, a variety of modifying factors, including data source and date, sample type, a size

cluding data source and date, sample type, size and number were added. Data sheets were formatted to make them compatible with the machine-readable coal resources data bank.

A methodology for reserves computation was developed to insure a rapid, relatively accurate, and useful reserves estimates for the MWCF.

4.3.3 Data Collection and Analysis

A summary of the principal tasks in this phase of the study is detailed in Figure 4-19. During this phase, the content of the producer data bank (Figure 4-20) was established. Producer questionnaires (designated questionnaire I and II) were tested, modified, and distributed.

With return of the questionnaires and preliminary analysis of the data, data gaps were identified and further contact with specific producers completed

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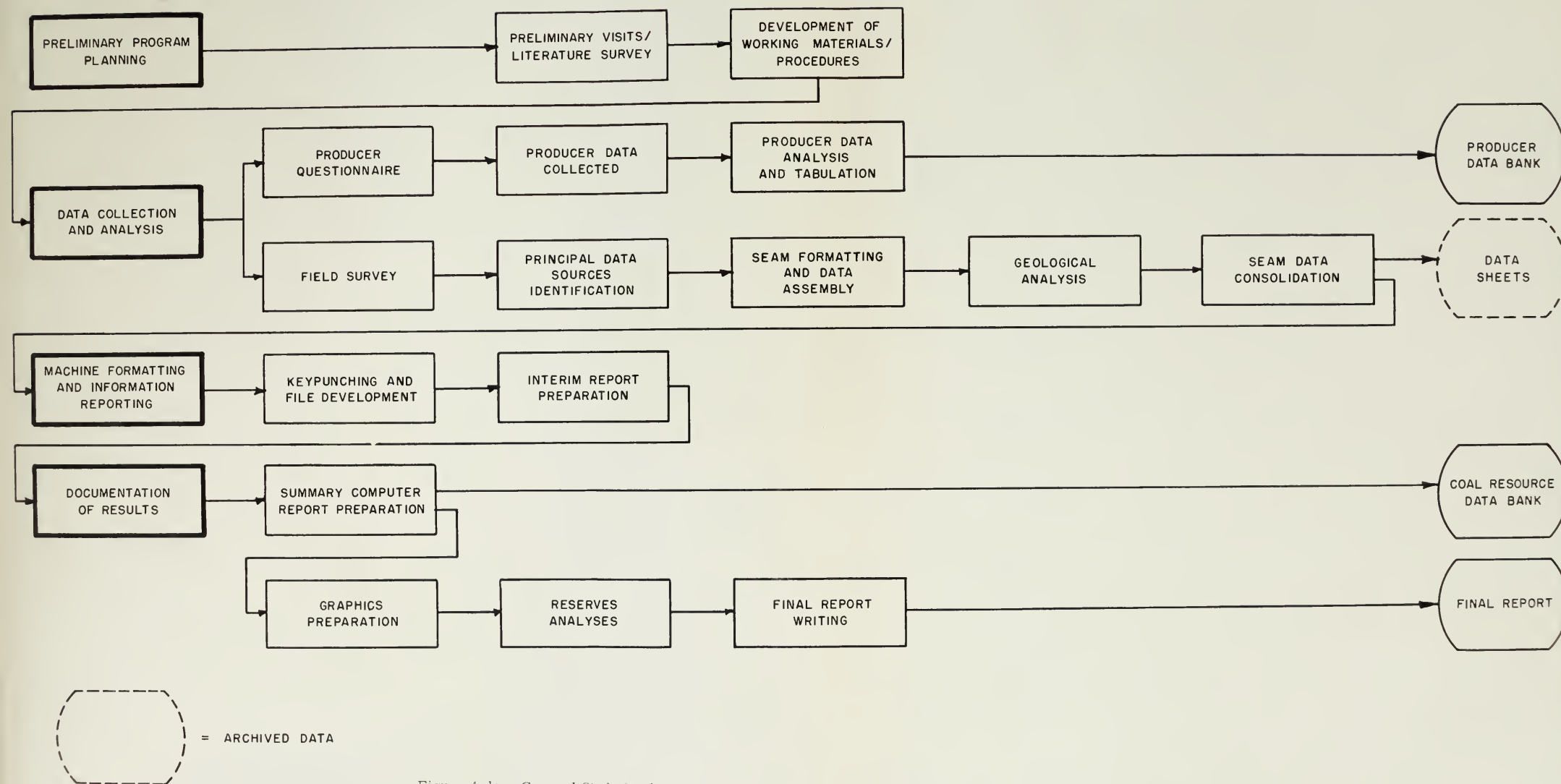


Figure 4-1. General Study Methodology

PRELIMINARY VISITS/LITERATURE SURVEY

- Visit Major Source-Agencies
- Evaluate Major Sources of Data
- Collect and Organize Basic Reference Materials

WORKING MATERIALS/PROCEDURES DEVELOPMENT

- Establish Geographic Reference System
- Develop Base Map and CLG Data
- Establish Coal Seam Correlation Chart
- Establish Data Control Procedures
- Design Producer Questionnaires
- Design Unit Area and County Data Sheets
- Develop Reserves, Computation Methodology

FIGURE 4-17 Summary of Preliminary Program Planning Phase

- Illinois Air Pollution Control Board
- Illinois Department of Business and Economic Department
- Illinois Department of Mines and Minerals
- Illinois Geological Survey
- Indiana Geological Survey
- Kentucky Geological Survey
- Mid-West Coal Producers: Institute Incorporated
- National Coal Association
- U. S. Bureau of Mines
- U. S. Department of Commerce (Census Bureau)
- U. S. Geological Survey
- United Mine Workers
- Tennessee Valley Authority

FIGURE 4-18 Contacts during preliminary data survey period

PRODUCER QUESTIONNAIRE

Producer Data Collection

- Confirm Content of Producer Data Bank
- Distribute Producer Questionnaires

Producer Data Analysis and Tabulation

- Organize Returns and Conduct Preliminary Data Analysis
- Identify Data Gaps and Complete Follow-Up Contacts
- Update Data Bank and Complete Analysis
- Tabulate and Finalize Data Bank

FIELD SURVEY

Principal Data Source Identification

- Confirm Content of Resources Data Bank
- Assess Needs and Utility of Data Bank to Other State Users
- Finalize Seam and Coal Quality Data Elements
- Assess Scope and Availability of Existing Data and Fill Data (Element) Needs

Data Formatting and Assembly

- Test of Consistency in Data Transfer
Transfer Statistical Data to Data Sheets

Geological Analysis

- Test for Consistency in Data Analysis
- Analyze Unit Area and County Data Sheets
- Identify Data Gaps and Conduct Supplementary Data Collection
- Complete Analysis and Review Data Sheets
- Conduct Air Analysis and Validate Data Sheets

Data Consolidation

- Consolidate Data Sheets and Establish Data Records
- Conduct Air Analysis and Validate Data Records

Fig. 4-19 Summary of Data Collection and Analysis Phase

PRODUCER-RELATED DATA BY COMPANY	PRODUCER COOPERATION ESSENTIAL - LARGELY UNAVAILABLE FROM OPEN SOURCES	PRODUCER COOPERATION USEFUL	PRODUCER COOPERATION OBTAINED	SUPPLEMENTED BY OPEN SOURCE MATERIALS
MINING METHOD		X	Yes	Yes
PRODUCING SEAM		X	Yes	Yes
PRODUCTION, RAW	1968		Yes	Yes
	1969	X	Yes	Yes
	(estimated) 1970		Yes	No
	(estimated) 1971		Yes	No
	(estimated) 1972		Yes	No
PRODUCTION, CLEANED	1968	X	Yes	Yes
	1969	X	Yes	Yes
	(estimated) 1970		Yes	No
	(estimated) 1971		Yes	No
	(estimated) 1972		Yes	No
TOTAL RESERVES			Yes	Yes
RESERVES, BY SULFUR CONTENT			Yes	No
DEDICATED LOW SULFUR COAL RESERVES BY USER	X		Yes	No
RESERVES LOCATION	X		No	No
RESERVES OWNERSHIP	X		No	No

Figure 4-20

Producer-Related Data versus available sources of information.
Data concerning reserves location and ownership could not be readily obtained from producers.

with the assistance of the Mid-West Coal Producers' Institute. After updating the basic data, the producer data bank was prepared.

The scope of the resources data bank was defined, and several specific data elements,

defined, and several specific data elements, including ash softening temperature (AST), free swelling index (FSI), added.

Data was then collected and transposed into the geographical and stratigraphic format selected. Updating of the data bank was maintained throughout the course of the study.

An essential part of this phase involved development of analytical criteria and comparison analyses techniques to insure precision and to minimize bias in the analyses. Visual estimates were compared, and in the analysis of (critical) sulfur and thickness values, revealed the following:

1. Visually estimated sulfur values are accurate to 0.1% of values determined mathematically for as many as 10 datum points. With increasing quantities of data, errors of $\pm 0.2\%$ were noted.

2. In all test cases where low and high sulfur boundaries were crossed, bi-modal distribution data was detected by analyst.

3. Evaluations of seam thickness showed errors of $\pm 2\%$ for fields of up to 25 values. Variations did not appear dependent upon the number of datum points.

Slight ambiguity unrelated to analytical procedure was, however, noted. For example, thickness values for mined-out pockets of lenticular coal most commonly referenced in open sources were not representative of remaining coal in place.

Data analysis was based upon weighted averages, modified as necessary by geological judgment and using analytical criteria related to (a) location, i.e., the accuracy to which the data point might be related to the proper seam and geographic position; (b) sample, i.e., variations in coal quality related to the conditions under which the sample was obtained and; (c) source, i.e., variations in the data value or accuracy because of age or source. These criteria have been summarized in Figure 4-21. Where it was necessary to draw conclusions based on limited or apparently inadequate data, (principally tertiary data) the data sheet was assigned an implied level of confidence.

After testing to insure consistency, statistical data summarized on approximately 20,000 data sheets were analyzed for county and unit areas to develop data records. The value was determined for each seam.

Consolidated data records were once again reviewed and validated. Unit area and county data records (Figures 4-22 and 4-23) then constituted the basic input into the machine-readable data bank.

4.3.4 Machine Formatting and Information Reporting

A summary of the principal tasks of this phase of the study is provided in Figure 4-24. Approximately 4,500 punched cards were prepared by seam for unit and county areas. The computer file was designed and interim (working) listings and reports

were prepared, reviewed for errors, and revised. An updated set of punch cards and magnetic tapes provided the data base for intensive analysis of reserves.

To assess the validity of the reserve estimate techniques, the initial determinations of reserves were compared with reserve estimates obtained from detailed mapping. Errors amounting to 10% were judged consistent with the time constraints of the study and needs of the Illinois Air Pollution Control Board.

Despite satisfactory test results, the techniques used (particularly that based on extrapolation of mean thickness data over a relatively large area) are subject to some errors arising from geological variations in coal seams.

4.3.5 Documentation of Results

A summary of the principal tasks in this phase may be referenced in Figure 4-25.

Initial computer reporting provided for the preparation of special reports to facilitate graphic preparation of sulfur distribution by seam. A series of special reports, including total reserves, reserves by seam and sulfur category, were prepared to facilitate development of low sulfur coal reserves information. After analysis, the general availability of low sulfur coals for air pollution control purposes was defined.

5.1 LOW SULFUR COAL AVAILABILITY

5.1.1 Definition of Available Reserves

The concept of reserves varies among geologists, mining engineers, and coal producers; definition of basic terminology used in this study is therefore desirable.

Original reserves describe that coal in place (i.e., in the ground) before mining operations. Estimates have been made in this study for original coal reserves by unit area, i.e. townships in Illinois and Indiana, and quadrangles in western Kentucky. A conversion factor of 1,152,000,000 tons per square mile-foot of coal was used for calculating reserves based on a specific gravity of 1.32. This factor was used with mean thickness to determine coal reserves in place, **without** regard to availability. Determination of original reserves provide the necessary base for calculating remaining, and finally, available reserves.

Reserves in place as of January 1, 1970 are considered remaining reserves regardless of the feasibility of mining. Remaining reserves were calculated by subtracting mined-out areas from original reserves.

Available reserves¹ are defined for this study as low sulfur remaining reserves as of January 1, 1970 - with allowances for areas lost to mining and probable non-recoverability (losses) of coal in place. Available reserves include coal seams 24 or more inches thick regardless of depth.

A lower thickness limit of 24 inches was used largely because many economists and geologists have agreed that it is the minimum thickness likely

¹ The term "total available reserves" is used for reserves regardless of sulfur content.

CRITERIA		WEIGHTING OF STATISTICAL DATA POINTS		
General	Specific	Primary	Secondary	Tertiary
Location	Geographic	Data point well established as to unit area, usually to section (Illinois and Indiana) or quadrant (W. Kentucky), and confirmed by several sources, e.g., reference maps and geologists with area experience	Data point established as to unit area using a single source, e.g., published document.	Data point very difficult or impossible to fix, e.g., several identically named mines in the same area, or location fixed with respect to ill-defined reference points.
	Stratigraphic	Data point well fixed with respect to coal seam, most often by repetitions references from a variety of sources.	Data point reasonably well defined by a single source or subject to correctable errors due to local correlation problems or erroneous seam designations.	Data point subject to errors due to local correlation problems or erroneous seam designations which are very difficult to correct with certainty.
Sample	Sample Type	Face channel samples (samples taken at coal face and mixed to establish bulk coal composition) and raw tipple samples (samples taken at mine tipple).	Tipple samples when information as to cleaning only suggests raw coal; hand (outcrop) or core (underground) samples. Delivered samples where preparation is reasonably assured.	Delivered samples when preparation details are unavailable or doubtful; all samples have been washed or partially washed. Note: Washed samples are a principal data source for cleaned sulfur evaluations in the absence of better data.
	Size of Coal	Run of mine coal, or "lump" sizes approximately 4 inches, believed representative of bulk coal.	Size fractures 4 inches but larger than 1 1/2 inches, which require careful evaluation for quality bias.	Size fractures less than 1 1/2 inches and all "pulverized" coal for which a quality bias (especially sulfur and ash content) may be introduced.
Source	Age of Data	Data point very indicative of coal currently available, i.e., 1950 to date for coal quality data, for seam thickness data.	Data point is somewhat indicative of coal currently available, i.e., 1910-1950 for coal quality data and 1900-1950 for seam thickness data.	Data point probably weak for indicating coal in place, i.e., 1910 or older for coal quality and 1900 or older for thickness data.
	Technical Expertise	State or Federal agencies with documented expertise in coal geology, and coal producers.	State or Federal agencies, coal industry and public information sources.	Unconfirmed verbal reports regardless of source.

Fig. 4-21 Criteria for Evaluation of Township and County Statistical Data

When visual methods of weighting proved difficult, detailed calculations were made. Particular attention was given bimodal distributions, especially when low (2.5%) sulfur values were included; separate data sheets were prepared when sample data suggested that a significant boundary had been crossed in sampling.

Ill. State		Washington County		Twp/Rge/Carter Sec.		Herrin #6		Seam Name(s) or Number(s)	
Seam Thickness (in.)	Sulfur % (dry basis)		Depth of Overburden Range (ft)	Source & Date	Remarks	Initials			
	Pyr.	Org.					Total	Cleaned	
10	-	-	-	AF 51	Can 1 in 92 234 28"	Bm			
70	.8	2.3	3.2	CAP	Base on 4 samples, Sec. 13, SP, FB	Ca			
54	-	-	4.8	CAP	Base on 8 samples, Sec 13, SP, FB	Ca			
148	-	-	4.8	Bu 62	1 mine (Comp 3) (130 m)	g			
30	2.6	2.3	4.7	Bu 62	1 mine 32 samples Tappan	D			
84	2.8	2.2	5.0	O 34 12/69	-	g			
72	-	-	-	Cms B 11 1922	Boring	PT			
72	-	-	-	"	"	D			
24	-	-	-	"	"	D			
84	-	-	-	"	"	D			
60	2.6	2.2	4.5	B.o.m.p.o.	1 mine 2 samples (Delivered) 1, 17, 24 BOM 2" x 4" Plant	D			
70	2.0	-	2.0	"	2 samples crushed ROM	D			
072	26	23	48	0380	(A) I Confidence				
				Tshp. Area (sq. mi.)		CLG Factor			
				36		0.92			

Washington D
County 4 Tshp. 333

Tshp. Work Sketch

Code	Thin or absent	Decimal %	Entry Date
T	Thin or absent	-	50
M	Mined out	20.11-14	69
C	Cut out	0.04	50
U	Under towns	0.04	69
D	Heavily drilled	-	69
G	Gas stg. areas	-	69
F	Faulted	-	69
	Other	-	-
	1.0 minus	0.78	equals
	Total		

Fig. 4-22

Unit Area Data Record

ILLINOIS COAL STUDY - COUNTY SUMMARY

ILL.		MONTGOMERY				W-Sul		HERRIN # 6	
State		County				Seam Name or Number			
Seam Thickness (in.)	Total Sulfur (% dry basis)	Cleaned Sulfur (% dry basis)	Total Ash (% dry basis)	BTU's per pound (as rec'd)	AST °F (at fusion)	FSI	Depth of Over-Burden Range (ft.)	Remarks (Reserves, type of sample, source, etc.)	
84-90	3.5-5.5	?	-	-	-	-	650-680	11/69 Q64 1 sample	
-	4.5	-	15.7	9980	1970	3 1/2 (1)	-	1 sample KI 7104 1967	
-	-	-	-	12,100	-	-	-	Bn 78 max P26	
-	4.2-5/09 4.2	-	8.3-10.7 10	-	-	-	-	IC 8301 P12 1966	
76-91	5.5	4.5	-	-	-	-	305-600	Q34 7 sample 12/69 L	
84-90	3.5-5.5 4.8	-	11.8	10730	-	-	650-680	Q64 1 sample 1/69 L	
-	-	-	-	-	-	-	-	5 mines, 20 samples 5 sections Bn 62	
-	-	-	12.4	-	2043	-	-	2 mines 9 samples Bn 62	
072-96	3.5-5.5	4.1-4.5	11	100-112	2000	3.5			

MONTGOMERY
County

MACHINE FORMATTING AND INFORMATION REPORTING

Key-Punching and File Development

- Analyze Report Needs and Design File
- Key-Punch Data Records
- Interim Report Preparation and Revision
- Review Information (Report) Requirements
- Prepare Interim Listings and Reports
- Review Listings and Reports and Make Revisions
- Update File, Cards and Tapes

Figure 4-24 Summary of Machine Formatting and
Information Reporting Phase

DOCUMENTATION OF RESULTS

Final Computer Report Preparation

- Prepare Special Reports to Facilitate Graphics Development
- Prepare Reserves (By Seam and Sulfur Category) Reports

Reserves Analysis

Analyze Reserves Reports

- Develop Graphics showing Sulfur Distribution by Seam
- Define Supplementary Report Needs
- Prepare and Analyze Supplementary Reports
- Summarize Results

Final Report Writing

- Assemble and Organize all Working Materials
- Prepare Final Report

Figure 4-25 Summary of the Documentation of Results Phase

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summum (No. 4)	Colchester (No. 2)
Adams					625,241
Bond		2,451,950	299,867		2,092
Brown					385,689
Bureau	424,110	649,427			1,221,789
Calhoun		55,884	49,049		15,015
Cass					452,957
Champaign	181,884				
Christian	61,454	3,556,511	1,336,119		
Clark	316,655	11,848	511,149		
Clay		916,819	702,311		
Clinton		3,236,433	552,248		
Coles	312,112		44,046		
Crawford	211,152	571,817	929,166		
Cumberland		162,249	171,260		
De Witt			173,619		
Douglas	726,829		11,011		
Edgar	950,564	721,363	441,330		
Edwards		684,316	449,545**		
Effingham		622,072	1,164,351		
Fayette	296,023	2,773,953	159,646		
Franklin		2,213,231	2,031,768**		
Fulton	58,882	255,218	785,188	5,448	1,319,301
Gallatin		1,151,820	1,301,483**		
Greene		49,556		25,199	583,496
Grundy		33,832		10,638	344,353
Hamilton		2,611,967	2,143,324**		
Hancock					29,829
Hardin					
Henderson					53,111
Henry	58,878	260,289			668,819

Figure 4-26.

DeKoven	Davis	Rock Island (No. 1)	Visc. Coals	Total	Percent Strippable
			2,472	625,241	99.0
				2,756,381	
				385,689	100.0
				2,295,326	19.7
				15,015	100.0
				557,890	43.8
				181,884	
			86,660	5,040,744	
			379,885	1,219,537	
				1,619,130	
				3,788,631	
				356,158	
			533,786	2,405,921	
			3,845	337,354	
				173,619	
			10,063	747,903	
			878,904	2,992,161	
				1,133,861	
				1,786,423	
				3,229,622	
362,147	507,878		62,040	5,177,064	87.2
651,697	858,038	5,458	6,892	2,429,495	5.9
				3,969,930	91.2
3,557	5,336			658,251	10.0
				888,823	
1,177	2,421			4,764,184	
				29,829	100.0
				3,598	
		76,660		53,111	100.0
				1,064,646	58.3

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summit (No. 4)	Colchester (No. 2)
Jackson		236,551	218,494		197,789
Jasper		1,861,661	1,415,200		87,052
Jefferson		2,848,713	2,003,784**		803,634
Jersey	10,482	71,256			1,452,560
Kankakee		36,055			
Knox	2,523	310,691	649,929		
La Salle	489,782	217,346			
Lawrence	223,427	1,186,698	985,024		
Livingston	267,427	370,566			2,351,608
Logan			2,589,660		
McDonough					
McLean	603,370		316,337		584,339
Macon		162,928	1,689,960		296,406
Macoupin	15,510	3,935,453	43,026	32,328	1,632,416
Madison		1,943,928			660,331
Marion		1,218,246	748,495		
Marshall	337,384	9,749			858,033
Mason			23,271		23,775
Menard			2,054,365		17,859
Mercer					
Monroe		13,676	4,970		
Montgomery	24,972	3,743,720	523,812	85,909	558,844
Morgan		621,765	18,021	22,531	1,322,351
Moultrie		355,524			
Peoria	282,537	1,070,432	1,321,268		440,025
Perry		2,294,358	440,324		
Piatt			10,698		
Pike					
Putnam	197,035	78,876			144,401
Randolph		516,396	185,965		467,893
Richland					
Rock Island		1,191,832	932,509		
St. Clair		2,536,106	621,565		
Saline	78,422	1,361,979	1,139,573**	6,885	7,768
Sangamon		2,194,896	3,373,581		280,804

DeKoven	Davis	Rock Island (No. 1)	Miss. Goals	Total	Percent Shareholders
			257,749	712,794 3,276,861 4,852,497 279,527 125,107 1,824,583 2,159,688 2,950,929 2,989,601 2,589,660	54.8 78.9 21.9 36.8 12.9 1.6
		57,806	555,780		
				584,339 1,216,113 1,852,838 6,482,430 2,616,979 1,966,741 1,205,166 23,271 2,078,140 87,107	100.0 4.2 23.5 9.6
	126,363 4,675		697,334 8,015		
		69,248			80.4
				18,646 5,584,025 1,984,668 355,524 3,114,262 2,734,682 10,698 144,401 743,804 702,361	36.4 41.7 69.8 40.4
	133,353		513,415		100.0
					64.7
		62,133		2,124,341 62,133 3,157,671 4,438,591 5,853,367	67.5 39.5 12.2
698,270	1,142,516		3,178 4,086		

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summum (No. 4)	Colchester (No. 2)
Schuyler			113,393		606,151
Scott		6,120			253,499
Shelby	125,267	1,183,577	304,861		
Stark	57,703	442,507			25,781
Tazewell	4,152	69,687	129,386		202,528
Vermilion	1,712,155	702,569			
Wabash		575,908	513,063**		369,414
Warren					
Washington		3,462,823	650,598		
Wayne		2,349,795	1,700,575**		
White		2,364,131	2,279,710**		
Will				2,648	
Williamson	22,610	823,044	920,669**		990,850
Woodford	38,560		144,770		
	8,091,861	65,360,117	41,323,335	191,586	20,877,177

* Totals include coal seams 28 inches or more thick in all classes of reliability as defined in Reference 2. Strippable coals include coals 18 inches or more thick and under 150 feet or less overburden. These totals do not include coal produced or rendered unminable since the date of each resource study. Data are compiled from Illinois State Geological Survey publications, References numbered 2, 15, 19, 20, 21, 22, 23 30, 33, 38.

** Reserve estimates for the No. 5 Coal in all or part of these counties have been made using different bases than reserve studies cited above and are not included in this list.
See Reference 46.

Figure 4-26. (Continued).

DeKoven	Davis	Rock Island (No. 1)	Misc. Coals	Total	Percent Strippable
			18,799	719,544 259,619 1,632,504 525,991 405,753	100.0 87.2 100.0 36.9
		39,000	44,521 99,855	2,459,245 1,188,826 408,414 4,113,421 4,050,370 4,674,868 41,347 3,323,867 1,174,180	98.5
13,823	17,204				52.2
754,702	634,300		165,894		19.6
2,485,373	3,432,084	310,305	4,493,173	146,565,014	

to be mined extensively in the next decade. Thinner coals have been mined over the MWCF to serve local markets and generally involved relatively small commercial operations.

The basic criterion of availability was recoverability. It should be noted however, that the percentage of available reserves *actually* recoverable is a function of the thickness and quality of coal, and geological conditions (mineability) which vary with the individual mining properties over the MWCF. The extent to which geological limitations, including faulting, the great depth of relatively thin seams or extent of channel sandstones limit recovery or make mining impractical altogether are impossible to evaluate in detail. A 70% recoverability factor has been applied to strip coals (149 feet or less deep) and a 50% recoverability factor applied to deep (150 feet or more) coals.

As in most mineral resources evaluations, portions of this report were necessarily based upon limited sample data and/or undesirable sample density. The reserve estimates presented will require modification as additional mapping or statistical data become available. It is possible that some reserves data here presented will be increased rather than decreased with additional exploration. For example, the 70% recovery for strippable reserves is considered conservative for a specific operation and the recovery percentage in some areas may exceed that estimated in this report.

Delineation of "strippable" versus "deep" reserves in this report is based upon mean area thickness of overburden (less than 150 feet for strip coal). Actual strip mining requires precise information on overburden thickness, composition of overburden and strip ratio dependent on local economic factors - all of which are usually conducted during the planning phase - preparatory to stripping.

Strippable coal as used in this report is coal which is largely strippable.

The procedure used to determine available reserves is summarized in Figure 5-1.

No complete analysis to resolve the many differences between data available to this study published or unpublished materials available to State or Federal agencies was possible. Independent judgements have been partly based on producer information and often in the absence of satisfactory sample density.

5.1.2 Definition of Low Sulfur Coal

The use of the term "low sulfur coal" varies. Sulfur levels greater than 1% are considered relatively high in some portions of West Virginia. In Illinois, where most reserves vary from 3% to 5% sulfur, a sulfur content of 2.5% or less is regarded as low sulfur coal. Coking coals are generally high sulfur coals if their sulfur content exceeds 1%.

Definition of low sulfur coal has been based largely on discussion of national sulfur standards in 1969. Principal attention has been given to the Chicago Air Quality Control Region which includes the counties of McHenry, Lake, Kane, Cook, DuPage, and Will in Illinois, and Lake and Porter counties in Indiana. Based upon sulfur requirements in the metropolitan Chicago area and several other large cities

within the MWCF, coal with a natural (raw) or cleaned sulfur content of less than 2% is defined as low sulfur coal.

High sulfur coal which can be cleaned to a low sulfur product of less than 2.0% is designated "low sulfur-cleaned coal" in this report.

It is expected that coal with less than a 1% sulfur content will be required for air pollution control purposes as more stringent sulfur standards are imposed. While this study was being completed, changes in the air pollution ordinances in the city of Chicago were implemented. These sulfur standards are summarized in Figure 5-2.

5.1.3 Scope of the Resources Data Bank

Statistical content of the resources data bank has been developed from geological data provided by coal producers and state and federal sources. Basic geological records have been archived with the Illinois Air Pollution Control Board for reference purposes, and producer data with the Midwest Coal Producers Institute (MWCPI).

The data bank consists of:

Machine readable punch card file

The file contains a statistical base upon which all computations are based, including reserves computations by seam, unit area and county.

Unit area computer listing

The listing summarizes thickness, sulfur content, mean thickness of overburden, assigned confidence level in reserves and tons by seam. Included are working data such as the CLG factor used to compute reserves.

County computer listing

The listing contains a summary by seam for ranges of thickness, sulfur and thermal value (BTU), and mean values for ash, ash softening temperature (AST) and free swelling index (FSI).

Special Computer reports

The structure of the machine readable data bank permits preparation of many special reports. Those prepared for this study are intended to serve the immediate needs of the study.

Data records

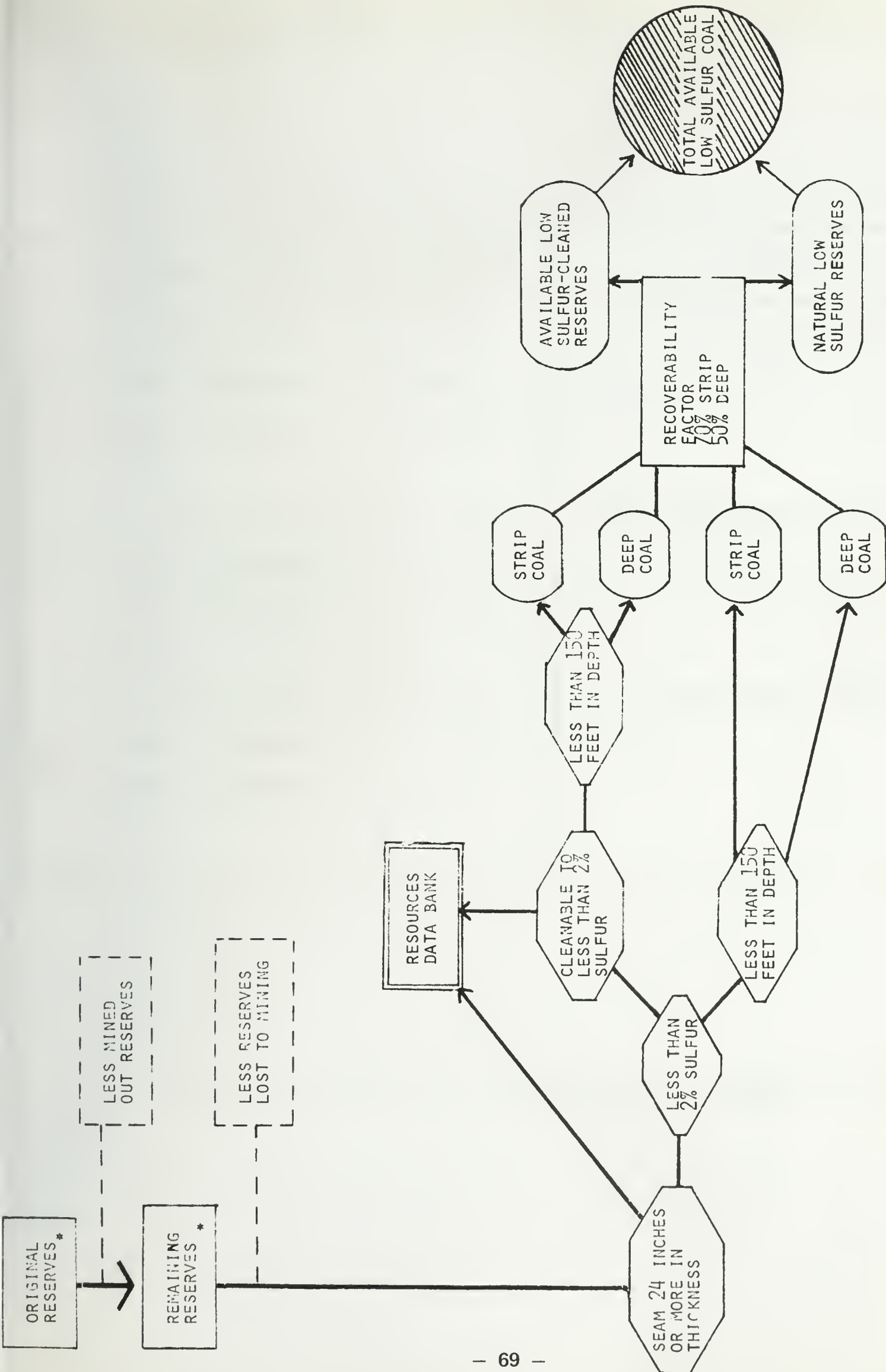
This includes all data sheets for township and county on which the punched card file is based.

A copy of unit area listings, and county listings, have been provided to supplement the machine readable punched card file.

5.1.4 Producer Data Bank

Information supplied by participating producers include production figures projected to 1972 (Figure 5-3A) and reserves by sulfur category (Figure 5-3B). Because of the confidential nature of this data, the names of participating companies have been concealed. A key to this figure must be requested from the Midwest Coal Producers' Institute, Chicago, Illinois.

Data included in the producer data bank is difficult to validate. For example, some companies probably did not include coal used in the mine or sold to



* ALL SULFUR CLASSES

FIGURE 5-1 PROCEDURE USED TO DEFINE AVAILABLE LOW SULFUR COAL RESERVES

PURPOSE	% Sulfur	Effective date
SPACE. HEATING	2.0%	July 1, 1970
	1.25%	September 1, 1971
	1.0%	September 1, 1972
INDUSTRIAL AND PROCESS PLANTS	2.0%	July 1, 1970
	1.5%	November 1, 1970
	1.0%	September 1, 1971
ELECTRICAL POWER PLANTS	1.8%	July 1, 1970
	1.5%	November 1, 1970
	1.0%	September 1, 1971

Figure 5-2 Summary of new ordinances on the burning of coal in the Metropolitan Chicago area.

ILLINOIS

Production - Raw

Company	Location	County	Mine	Seam	1968	1969	Est. 1970	Est. 1971
15	-	14	-	6	-	-	-	-
19	-	13	S	6	-	24,000	20,000	-
14	5	6	D	6	336,518	345,156	2,353,000	3,000,000
5	12	17	D	6	46,326	-	-	-
9	18	10	S	6	1,620,958	2,346,000	-	-
	2	15	S	5&6	1,740,240	1,801,000	-	-
	9	5	D	6	990,222	1,150,513	-	-
	24	19	S	5	2,611,833	-	-	-
	15	19	S	5&6	-	-	-	-
13	21	5	D	6	2,108,824	-	-	-
	7	6	D	6	2,835,812	-	-	-
	20	26	D	6	957,155	-	-	-
	10	9	D	6	1,882,020	969,000	1,165,000	1,165,000
	7	6	D	6	11,704	525,000	380,000	-
7	5	9	D	6	2,126,918	-	-	-
	16	9	D	6	2,644,331	*3,187,179	3,100,000	3,100,000
	5	9	D	6	263,959	*2,976,911	2,600,000	2,600,000
11	4	13	D	5	692,543	-	-	-
	4	13	D	6	775,101	-	-	-
	4	13	S	5	1,059,629	-	-	-
	-	-	D	-	-	-	-	-

Figure 5-3A.

Est. 1972	Production-Cleaned					Est. 1972	Est. 1972	Est. 1972
	Or-site Cleaning	1969	Est. 1970	Est. 1971	Est. 1972			
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
3,529,000	x	*800,000	2,000,000	2,550,000	3,000,000	3,000,000	3,000,000	3,000,000
-	x	48,000	50,000	50,000	50,000	50,000	50,000	50,000
-	x	1,830,797	-	-	-	-	-	-
-	x	1,351,000	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	x	878,000	-	-	-	-	-	-
-	x	1,271,000	-	-	-	-	-	-
-	x	2,113,000	2,229,000	2,304,000	2,304,000	2,304,000	2,304,000	2,304,000
-	x	2,759,000	3,060,000	3,264,000	3,264,000	3,264,000	3,264,000	3,264,000
-	x	1,136,000	1,251,000	1,269,000	1,269,000	1,269,000	1,269,000	1,269,000
1,165,000	-	*353,000	-	-	-	-	-	-
-	x	*532,000	2,403,000	3,120,000	3,120,000	3,120,000	3,120,000	3,120,000
-	x	2,272,464	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
-	-	-	-	-	-	-	-	-
2,600,000	x	1,200,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
-	x	850,000	850,000	800,000	800,000	800,000	800,000	800,000
-	x	950,000	500,000	400,000	300,000	300,000	300,000	300,000
-	x	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000
-	x	-	450,000	600,000	700,000	700,000	700,000	700,000

Production - Raw

Company	Location	County	Mine	Seam	1968	1969	Est. 1970	Est. 1971
3	25	19	S	5	738,055	-	-	-
	18	10	S	6	1,844,093	-	-	-
	14	19	S	5	2,002,346	1,269,000	1,123,000	-
	1	24	S	5	675,217	-	-	-
8	13	26	D	6	1,062,493	*75,000	-	-
	22	3	D	6	653,830	*50,000	-	-
	2	15	D	6	912,787	-	-	-
	8	7	S	6	5,804,693	-	-	-
4	23	7	S	6	653,774	-	-	-
	19	24	S	6	412,546	-	-	-
	11	37	S	3	962,484	-	-	-
	6	8	S	6	-	-	-	-
	17	26	S	Davis DeKoven	1,225,815	-	-	-
	8	7	D	6	-	-	-	-
	23	7	D	6	517,856	-	-	-
	6	7	D	5	-	-	-	-
	6	8	D	5	-	-	-	-
	3	25	D	6	5,325,673	-	-	-
	-	-	D	-	-	-	-	500,000
	-	-	D	-	-	-	-	-

Figure 5-3A. (Continued).

Est. 1972	Production-Cleaned					Footnotes
	On-site Cleaning	1969	Est. 1970	Est. 1971	Est. 1972	
-	x	805,608	635,000	660,000	660,000	
-	x	1,833,950	1,863,000	1,900,000	1,900,000	
-	x	993,000	*919,000	1,500,000	1,500,000	
-	x	685,932	703,000	675,000	675,000	
-	x	*1,016,000	1,200,000	1,200,000	1,200,000	
-	-	857,000	-	-	-	
-	-	973,638	1,000,000	-	-	
-	x	5,151,000	4,521,000	4,899,000	4,746,000	
-	-	635,000	100,000	-	-	
-	x	578,000	695,000	695,000	741,000	
-	x	1,047,000	1,037,000	976,000	952,000	
-	x	1,156,000	1,350,000	1,600,000	1,599,000	
-	x	1,336,000	922,000	868,000	1,056,000	
-	x	-	837,000	1,411,000	2,079,000	
-	-	480,000	80,000	-	-	
-	x	1,458,000	1,542,000	1,542,000	1,542,000	
-	x	316,000	1,302,000	2,437,000	2,892,000	
-	x	5,539,000	5,226,000	5,224,000	5,224,000	
1,500,000	-	-	-	-	-	
-	x	-	-	720,000	1,586,000	

INDIANA

Company	Location	County	Mine	Seam	Production - Raw				Est. 1971
					1968	1969	Est. 1970		
17	11	46	D	V	850,000	765,831	1,065,000	1,312,000	
2	18	35	S	V	1,675,000	-	-	-	
	1	35	S	V	1,419,000	-	-	-	
10	-	44	S	Block	-	5,000	5,000	5,000	
4	9	48	S	V	3,520,675	-	-	-	
	4	34	S	V	1,507,090	-	-	-	
	-	17	S	V	-	-	-	-	
	-	33	S	III, VI, VII	-	-	-	-	
18	-	39	S	Block	497,202	-	-	-	
	14	46	S	V	383,422	789,041	-	-	
	2	39	S	III	1,035,346	1,156,517	-	-	
	13	34	-	VI, VII	1,735,956	1,646,385	-	-	
	6	48	S	V	1,176,793	1,611,375	-	-	
	24	34	D	V	1,033,435	1,072,528	-	-	
	6	48	S	VI	1,432,696	1,523,634	-	-	

Figure 5-3A. (Continued).

Production - Cleaned						Footnotes
Est. 1972	On-site Cleaning	1969	Est. 1970	Est. 1971	Est. 1972	
1,312,000	x	700,000	990,000	1,220,000	1,220,000	* Estimate
-	x	702,852	1,667,000	1,657,000	2,245,000	
-	x	701,677	1,456,000	1,468,000	1,670,000	
5,000	x	4,000	4,000	4,000	4,000	
-	x	761,213	4,226,000	4,130,000	4,578,000	
-	x	241,290	1,413,000	1,427,000	1,477,000	
-	x	-	1,080,000	1,407,000	2,569,000	
-	x	137,985	2,600,000	2,722,000	2,750,000	
-	-	151,414	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	

KENTUCKY

Production - Raw

Company	Location	County	Mine	Seam	1968	1969	Est. 1970	Est. 1971
1	21	40	D	9	1,409,243	1,817,000	-	-
10	16	50	S	9,11,12	750,878	1,000,000	1,000,000	1,000,000
	25	50	S	9,11,12	-	520,878	650,000	-
16	12	40	S	6	426,039	415,000	460,000	460,000
20	19	50	S	11,12	1,959,404	2,500,000	2,500,000	2,500,000
	21	40	S	9,11, 12,14	2,388,392	2,000,000	1,000,000	2,000,000
25	15	38	D	9	1,102,418	800,000	1,000,000	1,100,000
23	21	40	D	9,11	-	-	75,000	1,000,000
4	23	50	S	11,12	3,901,163	-	-	-
	23	50	D	11,12	1,236,437	-	-	-
	17	50	S	9	1,148,236	-	-	-
	17	47	D	9	1,564,597	-	-	-
	21	40	S	11,12	2,278,427	-	-	-
	5	47	S	9	835,468	-	-	-
	17	47	S	9,11,13	2,458,562	2,230,000	2,000,000	2,188,000
	20	50	S	11,12,13	4,451,183	-	-	-

Figure 5-3A. (Continued).

Production - Cleaned

Est. 1972	On-site Cleaning	1969	Est. 1970	Est. 1971	Est. 1972	Footnotes
-	-	-	2,000,000	2,000,000	2,000,000	
1,000,000	x	850,000	850,000	850,000	850,000	
-	-	*422,000	530,000	-	-	
460,000	x	365,000	405,000	405,000	450,000	
2,500,000	x	500,000	500,000	500,000	500,000	
2,000,000	x	*1,100,000	*1,100,000	*1,000,000	*1,100,000	
1,100,000	-	-	-	-	-	
1,000,000	-	-	-	-	-	
-	x	4,371,000	5,000,000	4,293,000	4,138,000	
-	x	1,601,000	1,462,000	1,473,000	1,494,000	
-	x	1,122,000	1,070,000	1,159,000	1,068,000	
-	x	1,605,000	1,905,000	1,892,000	1,872,000	
-	x	2,582,000	3,500,000	3,697,000	3,289,000	
-	x	731,000	800,000	800,000	800,000	
2,086,000	-	-	-	-	-	
-	x	4,440,000	4,900,000	4,900,000	4,900,000	

Reserves by Sulfur Content

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
15	14	6	-	-	56,000,000	-	-
19	13	6	-	-	24,000	-	-
14	6	6	96,000,000	24,000,000	-	-	-
5	17	6	200,000	-	-	-	-
9	11	6	-	-	40,712,000	-	-
	15	6	-	-	-	8,975,000	-
	15	5	-	-	-	12,915,000	-
	19	6	-	12,360,000	-	-	-
	19	6	-	9,730,000	-	-	-
	5	5	-	-	-	116,890,000	-
	17	6	54,713,000	35,290,000	-	-	-
	22	6	-	-	101,351,000	-	-
	8	5	-	-	-	52,085,000	-
	13	6	-	-	86,770,000	-	-
	4	5	-	-	-	30,919,000	-
	4	6	-	22,160,000	-	-	-
	21	5	-	-	21,990,000	-	-
	21	6	-	-	-	14,903,000	-
13	6	5	5,877,720	38,205,180	35,266,320	17,633,160	979,620
	6	6	20,119,000	10,059,000	2,349,000	1,005,000	-
	6	6	38,453,000	17,277,000	-	-	-
	26	6	-	6,762,340	10,470,720	4,580,940	-
	9	6	-	7,828,050	23,143,800	3,063,150	-
	16	6	-	-	544,570	32,165,060	22,737,370
	5	6	-	-	1,617,550	77,642,400	82,495,050
	25	6	-	-	-	-	11,642,000
	2	6	-	-	-	5,880,000	5,880,000

Figure 5-3B.

Low Sulfur (2% or Less)

Reserves Dedicated

Total Reserves	Util.	Coke Steel	Other Ind.	Retail	Exports
56,000,000	-	-	-	-	-
24,000	-	-	-	-	-
120,000,000 **25%		75%	-	-	-
200,000	80%	-	-	20%	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
599,773,000	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	56%	22.5%	18.3%	2.5%	-
483,687,000	-	-	-	-	-

**For burning in own utilities.

Assume 100% dedicated

E.Perry = 18,722,000; W.Perry=21,990,000.
Assume 100%

Undedicated low wulfur coal is available
for utilities

ILLINOIS

Reserves by Sulfur Content

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	over 5%
7	9	6	56,000,000	84,000,000	140,000,000	-	-
	9	5	-	-	137,382,000	137,383,000	-
	26	5	-	-	29,235,000	-	-
	25	6	-	-	-	48,000,000	-
	5	6	-	-	-	42,000,000	-
11	13	5	14,200,000	85,200,000	42,600,000	-	-
	13	6	-	-	46,000,000	-	-
3	19	6	-	12,419,000	-	-	-
	19	5	-	18,694,000	-	-	-
	10	6	-	69,991,000	-	-	-
	24	2	-	6,402,000	-	-	-
	12	2	-	12,550,000	-	-	-
	17	7	-	1,796,000	-	-	-
1	26	6	10,000,000	-	-	-	-
	3	6	-	21,000,000	-	-	-
	15	6	-	18,000,000	-	-	-
8	6						
	9	5&6	-	30,000,000	-	-	-
	26	6	37,000,000	-	-	-	-
	15	6	-	36,000,000	-	-	-
	16	6	-	-	56,000,000	-	-
	14	6	-	-	46,000,000	-	-
	3	6	-	11,000,000	-	-	-
	10	6	-	39,000,000	-	-	-
4	18	2	-	-	11,798,000	-	-
	24	6	-	14,098,000	-	-	-
	24	5	-	17,132,000	-	-	-
	29	6	-	-	1,835,000	-	-

Figure 5-3B. (Continued).

Low Sulfur (2% or Less) Reserves Dedicated					
Total Reserves	Util.	Coke Steel	Other Ind.	Retail	Export
-	-	100%	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
674,000,000	-	-	-	-	-
-	20%	20%	45%	15%	-
188,000,000	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
121,852,000	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
49,000,000	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
255,000,000	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Assume 100% dedicated

Reserves by Sulfur Content

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
4	26	De-Koven	-	-	-	3,104,000	-
	26	Davis	-	-	2,345,000	-	-
	26	4	-	-	716,000	-	-
	26	6	-	8,640,000	-	-	-
	26	5	-	483,000	-	-	-
	20	2	-	4,118,000	-	-	-
	10	6	-	-	99,398,000	-	-
	22	6	-	-	-	616,658,000	-
	14	6	-	-	56,862,000	-	-
	15	6	-	-	-	120,195,000	-
	7	6	-	-	-	411,739,000	-
	2	6	-	-	-	125,933,000	-
	23	6	-	-	-	220,652,000	-
	16	6	-	-	9,255,000	-	-
	13	6	-	7,668,000	-	-	-
	13	5	-	-	19,560,000	-	-
	13	DeKoven	-	-	-	1,966,000	-
	13	Davis	-	-	2,399,000	-	-
	13	4	-	-	485,000	-	-
	1	7	-	-	2,635,000	-	-
	17	6	-	2,956,000	-	-	-
	5	6	-	-	-	22,412,000	-
	27	6	-	-	-	249,443,000	-
	30	6	-	-	-	29,925,000	-
	28	6	-	-	-	-	-
	31	2	-	122,000	-	-	-
	12	2	-	167,000	-	-	-
	25	2	-	-	706,000	-	-
	32	6	-	-	-	247,954,000	-
	32	7	-	-	156,000	-	-
	32	2	-	1,042,000	-	-	-

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
4 contd.	37	2	-	5,990,000	-	-	-
	43	7	-	-	1,580,000	-	-
	43	2	-	4,000,000	-	-	-
	8	6	-	14,826,000	-	-	-
	8	5	-	-	127,064,000	-	-
	8	Davis	-	1,807,000	-	-	-
	8	DeKoven	-	1,070,000	-	-	-
	6	6	-	-	-	13,700,000	-

Figure 5-3B. (Continued).

Low Sulfur (2% or Less)					
Total Reserves	Reserves Dedicated				
	Util.	Coke Steel	Other Ind.	Retail	Export
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
2,484,594,000	-	-	-	-	-

Reserves by Sulfur Content

Name of Co	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
17	46	V	8,000,000	-	-	-	-
2	35	V	28,800,000	14,400,000	36,000,000	50,400,000	14,400,000
	48	V	-	-	-	7,000,000	3,000,000
	46	V	-	-	6,500,000	3,500,000	-
	41	V	-	-	21,685,000	21,685,000	-
	35	VII	7,557,000	-	-	-	-
	35	VI	100,000	-	-	-	-
	48	VI	392,000	-	-	-	-
	46	VI	55,000	-	-	-	-
	35	IV	-	-	467,000	373,600	93,400
4	39	III	-	-	-	2,059,000	-
	39	IV	389,000	-	-	-	-
	39	U. Bl.	39,000	-	-	-	-
	45	-	-	4,365,000	-	-	-
	45	IV	-	3,895,000	-	-	-
	46	Millersburg	-	-	16,880,000	-	-
	33	III	-	-	-	6,202,000	-
	33	IV	425,000	-	-	-	-
	33	U. Bl.	32,000	-	-	-	-
	33	** Rider	-	-	-	-	-
		V	-	**67,000	*5,434,000	-	-
	41	V	-	-	3,742,000	-	-
	51	U. Bl.	425,000	-	-	-	-
	35	**Millersburg	-	**1,104,000	*4,887,000	-	-
		*V	-	-	58,000	-	-
	34	U. Rider	-	-	15,214,000	-	-
	34	V	-	-	-	-	-

Reserves by Sulfur Content

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
4 contd.	34	VI	-	29,398,000	-	-	-
	34	VII	21,168,000	-	-	-	-
	46	V	-	-	37,108,000	-	-
	34	V, VI, VII	-	5,767,000	-	-	-
	36	III	-	-	7,464,000	-	-
	36	IV	-	-	700,000	-	-
	36	V	-	2,339,000	-	-	-
	36	VI	-	9,203,000	-	-	-
	36	VII	16,398,000	-	-	-	-
	17	VI	-	20,555,000	-	-	-
	48	V	-	-	93,851,000	-	-
	48	Millersburg	-	-	81,231,000	-	-

Name of Co.	County	Seam	2% or less	2.1 - 3%	3.1 - 4%	4.1 - 5%	Over 5%
1	40	9	-	-	-	42,000,000	-
10	50	6	40,000,000	-	-	-	-
	50	12	-	4,000,000	-	-	-
	50	11	-	-	6,000,000	-	-
16	40	6	10,000,000	-	-	-	-
	25	4	-	-	2,000,000	-	-
25	38	9	-	-	-	13,000,000	-
	49	6,11	-	-	-	40,000,000	-
23	40	9	-	-	-	16,000,000	-
	40	11	-	-	-	8,000,000	-
4	55	9	-	-	-	215,199,000	-
	40	7	-	-	-	518,000	-
	40	8	-	521,000	-	-	-
	40	9	-	-	-	820,000	-
	45	9	-	-	-	1,334,000	-
	47	14	-	-	-	15,251,000	-
	47	13	-	-	-	-	-
	47	11	4,358,000	-	-	18,437,000	-
	47	9	-	-	171,764,000	-	-
	47	6	-	7,082,000	-	-	-
	47	14Top	2,702,000	-	-	-	-
	47	14Bot	-	-	4,126,000	-	-
	47	11Bot	-	-	-	706,000	-
	50	9	-	-	141,401,000	-	-
	50	11	-	88,800,000	-	-	-
	50	12	-	-	64,708,000	-	-
	50	14	-	1,909,000	-	-	-
	49	14	-	8,830,000	-	-	-
	49	11	-	2,799,000	-	-	-
	38	9	-	-	-	76,946,000	-
	42	9	-	-	-	15,115,000	-
2	40	9	-	-	13,008,800	19,633,200	-

Figure 5-3B. (Continued).

[illegible]

employees in production figures which could account for variances with published governmental data.

For reference purposes, MWCF production of bituminous coal in 1964 according to sulfur class is shown in Figure 5-3C. The latest Bureau of Mines summary data for 1969 (dated September 1970) is excerpted in Figure 5-3D to 5-3K.

The generalized outline of producing areas as well as distribution of principal strip and deep mines are shown in Figure 5-4.

5.2 PAST STUDIES

The first comprehensive estimate of the coal reserves of the United States was made by M. R. Campbell of the U. S. Geological Survey between 1907 and 1929 although there was no consideration given to sulfur content.

A summary of coal reserve in Illinois is included in Cady (1952) who prepared one of the first intensive studies of coal reserves in Illinois. Maps and tabular reserves data were detailed by seam and county. Cady's work resulted in the compilation of a series of maps of 33 areas showing most of the available information concerning the coal resources by area and county of beds 28 inches or more in thickness. (Figure 5-5A).

This work has been supplemented by a strippable (18 inches or more in thickness) coal report series prepared for most of the state. A recent historical reserves summary and estimate of Illinois Coal Reserves have been completed by Simon and Smith (1968) and summarized in Figure 5-5B. The reserves data are summarized in Figure 5-6.

The major coals in Illinois are the Rock Island (No. 1) Coal, Colchester (No. 1) Coal, Springfield (No. 5) Coal, Herrin (No. 6) Coal and Danville (No. 7) Coal. The Davis and Dekoven coals are also being mined.

Spencer (1953) summarized early coal reserves estimates (Figure 5-8). He estimated Indiana coal reserves at 27,320 million tons contained in beds more than 42 inches thick, and the remaining Indiana coal reserves as of January 1, 1951, at 25,806 million tons, of which 18,779 million tons is believed to be recoverable. He indicated his estimates of reserves -- calculated and tabulated by seam by county -- were conservative, and that recoverable reserves in more deeply buried beds were at least three times that of strippable reserves.

A recent summary (Figure 5-9) of coal reserves in Indiana has been completed by Wier and Hutchinson (1970). They indicated coal deposits in Indiana occur in 25 counties in the southwestern part of the state, of which 20 contain commercially mineable coal beds, seventeen (17) of these having reserves sufficient for large scale mining operations.

Eight major coals and at least 25 additional coals occur in Indiana. The latter are not considered major commercial coals because of their irregularity, both in thickness and extent, although some have been (or are presently being) mined in small areas in the state. The major coal beds are designated, in ascending order: Lower Block coal, Upper Block coal, Minshall (Buffaloville) coal, Seelyville coal (III) Survant coal (IV), Springfield coal (V), Hymera (Lower Millersburg) or Coal (VI), and Dan-

ville (Upper Millersburg or Coal VII).

Averitt (1961) calculated total estimated original reserves in Indiana at 39 billion tons. The estimated recoverable reserves (assuming 50 percent recovery) amounts to 19.5 billion tons including coal seams between 14 and 30 inches thick.

In 1959, the Fuel's Planning Branch of the TVA began a coal reserve analysis of the entire western Kentucky coal field intended to assess present and potential coal supply areas for TVA facilities. Summaries of reserves by quadrangle, seam, thickness and depth to coal categories were summarized. TVA estimates amounting to over 14.3 billion tons are generally considered conservative by many coal companies, and do not include the Bell, Lower Otter Creek and Kentucky No. 7 coals. A series of area reports completed between 1962 and 1967 supplemented by more recent publications was prepared by the TVA Fuels Planning Branch and constitute basic data for coal reserves estimates in west Kentucky.

Sheridan (1968) surveyed the quality and available reserves of coal in Kentucky. He indicated that U. S. Geological Survey estimates of western Kentucky reserves at 36.9 billion tons, were realistic. The estimate was developed principally by assuming that the seams of adjoining States extended into western Kentucky. Quantitative data prepared were made by adjusting reserve estimates to reflect production and mining losses through January 1966, and supplemented with reserve data developed by the U. S. Bureau of Mines and Ford, Bacon, and Davis, Inc. (1951) report.

Mr. Gilbert Smith (personal communication, 1970), Kentucky State Geological Survey, provided the following summary of coal reserves for western Kentucky:

An early comprehensive study of the coal reserves was made by M. R. Campbell of the U. S. Geological Survey during the years 1907 to 1928. Campbell assigned tonnages by states. In 1952, Cady of the Illinois Geological Survey re-evaluated the reserves of his state and found them to be 68% of Campbell's figures. Spencer of the U.S. Geological Survey re-evaluated the reserves of Indiana in 1953 and found his totals to be 70% of those of Campbell.

When Huddle (1963, pp. 176-177) sought a reserve figure to go with his new evaluation for the Eastern Kentucky coal field he noted the similarity of the two re-evaluations of the neighboring states and assumed a value of 70% of Campbell's original estimates for Western Kentucky. This corrected estimate is 38,878 million tons of original reserves.

Recent coal reserve studies completed by TVA were compiled from data collected by them and the Kentucky Geological Survey. Using the values from the three published reports, unpublished (producer) data, and values from studies for a four quadrangle area evaluated by the Kentucky Survey, I arrived at an estimate of 14.3 billion tons. TVA used, however, a set of standards that make the evaluation incompatible with previous work. TVA considered only coals over 24 inches, not the accepted 14 inches, and they disregarded coals under

Production of Bituminous Coal and Lignite in the United States in 1964, According To
Sulfur Content and Producing District, 1966
(Short Tons)

*Innocuities introduced concealing company do not
warrant level of accuracy expressed by DeCarlo.
Totals round off for this study.

Producing district	Sulfur Content, Percent									Total
	0.7 and under	0.8 - 1.0	1.1 - 1.5	1.6 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.0	4.1 or more	
District 10:										
Illinois:										
Adoms.	-	-	-	-	-	-	28,109	-	-	28,109
Bureau	-	-	-	-	-	-	(2)	-	-	(2)
Christian	-	-	-	-	-	-	-	-	(2)	(2)
Douglas	-	-	-	-	-	-	-	(2)	-	(2)
Franklin.	-	-	-	(2)	-	-	-	-	-	(2)
Fulton.	-	-	-	-	-	(2)	6,984,660	-	-	6,984,660
Gallatin.	-	-	-	-	-	(2)	56,835	-	-	56,835
Greene	-	-	-	-	-	-	3,102	-	-	3,102
Grundy	-	-	-	-	-	-	(2)	-	-	(2)
Henry	-	-	-	-	-	-	-	-	(2)	(2)
Jackson	-	-	-	-	-	-	(2)	-	-	(2)
Jefferson.	-	-	(2)	-	-	-	-	-	-	(2)
Knox	-	-	-	-	-	-	(2)	-	-	(2)
Logan	-	-	-	-	-	-	21,899	-	-	21,899
Macoupin	-	-	-	-	-	-	-	-	373,937	373,937
Madison.	-	-	-	-	-	-	-	126,822	-	126,822
Menard	-	-	-	-	-	-	(2)	-	-	(2)
Mercer	-	-	-	-	-	-	-	-	(2)	(2)
Montgomery	-	-	-	-	-	-	-	-	(2)	(2)
Peoria	-	-	-	-	-	(2)	694,816	-	-	694,816
Perry	-	-	(2)	-	-	-	-	(2)	-	(2)
Rondolph	-	-	-	-	-	-	-	(2)	-	(2)
St. Clair	-	-	-	-	-	-	-	-	-	5,770,464
Saline	-	-	-	-	-	1,667,110	-	5,770,464	-	4,027,611
Sangamon.	-	-	-	-	-	-	-	2,360,501	-	79,286
Schuyler	-	-	-	-	-	-	-	-	79,286	(2)
Stark	-	-	-	-	-	(2)	-	-	-	(2)
Vermillion	-	-	-	-	(3)	(2)	-	(2)	-	(2)
Wabosh	-	-	-	-	-	-	-	-	-	1,103
Washington	-	-	-	-	-	-	-	1,103	-	(2)
Will	-	-	-	-	-	-	-	-	(2)	(2)
Williamson	-	-	-	(2)	-	-	1,909,145	-	-	1,909,245
Undistributed	-	-	6,127,976	10,418,025	-	2,567,578	3,833,330	3,840,767	8,157,037	34,944,713
District Total	-	-	6,127,976	10,418,025	(3)	4,234,688	13,531,996	12,099,657	8,610,260	55,022,602

- ¹ As established under the Bituminous Coal Act of 1935.
- ² Included with "Undistributed" to avoid disclosing individual company data.
- ³ Included with "2.6 - 3.0" to avoid disclosing individual company data.
- ⁹ Included with "1.1 - 1.5" to avoid disclosing individual company data.
- ¹⁰ Included with "0.7 and under" to avoid disclosing individual company data.

Figure 5-3C

Production of Bituminous Coal and Lignite in the United States in 1964, According To
Sulfur Content and Producing District -- Continued
 (Short Tons)

*Inaccuracies introduced concealing company do not warrant level of accuracy expressed by DeCarlo.
 Totals round off for this study.

Producing district ¹	Sulfur Content, Percent									Total
	0.7 and under	0.8 - 1.0	1.1 - 1.5	1.6 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.0	4.1 or more	
District 11:										
Indiana:										
Clay	100,932	-	-	-	-	-	-	-	864,554	965,486
Daviess	11,100	-	-	-	-	-	-	-	-	11,100
Dubois	-	-	-	-	-	-	-	10,500	-	10,500
Fountain	-	-	-	-	-	-	-	(11)	-	(11)
Gibson	-	-	-	-	-	-	-	561,329	-	561,329
Greene	-	-	1,552,712	-	-	-	-	-	-	1,552,712
Knox	-	-	-	-	-	64,899	-	-	-	64,899
Owen	-	(9)	(2)	-	-	-	-	-	-	(2)
Parke	-	-	-	-	7,416	-	-	-	-	7,416
Pike	-	-	-	-	-	-	-	2,268,465	-	2,268,465
Spencer	-	-	-	-	70,445	-	-	-	-	70,445
Sullivan	-	-	(2)	-	-	-	-	784,848	-	784,848
Vermillion	-	-	(2)	-	-	4,991	-	-	(12)	4,991
Vigo	-	-	(2)	(9)	-	-	-	378,193	-	378,193
Warrick	-	-	-	-	3,013,413	-	-	3,343,718	-	6,357,131
Undistributed	-	-	2,037,116	-	-	-	-	-	-	2,037,116
District Total	112,032	(9)	3,589,828	(9)	3,091,274	69,890	-	7,347,053	864,554	15,074,631
Kentucky:										
Butler	-	-	187,038	-	-	-	-	-	-	187,038
Christian	-	-	-	-	13,573	-	-	-	-	13,573
Daviess	-	-	-	-	-	-	-	-	876,601	376,601
Hancock	-	-	-	-	-	-	-	-	1,000	1,000
Henderson	-	-	-	-	-	-	-	-	155,227	155,227
Hopkins	-	-	-	-	-	-	-	-	-	10,263,283
McLean	-	-	-	-	-	-	-	18,498	-	18,498
Muhlenberg	-	-	-	-	-	-	-	17,634,686	-	17,634,686
Ohio	-	-	-	-	-	-	-	-	4,567,237	4,567,237
Union	-	-	-	-	-	-	-	4,067,691	-	4,067,691
Webster	-	-	-	-	-	-	-	70,985	-	70,985
District Total	-	-	187,038	-	13,573	-	10,263,283	21,791,860	5,600,065	37,855,819
NATIONAL TOTAL*	128.2	57.2	67.1	52.3	24.7	24.3	55.9	54.4	22.9	487.0

FIGURE 5-30.

Production of bituminous coal and lignite, in the United States, in 1969, by States, with estimates by months 1/
(Thousand short tons)

State	January	February	March	April	May	June	July	August	September	October	November	December	Total
Alabama--	1,467	1,305	1,456	1,467	1,405	1,334	1,172	1,506	1,646	1,694	1,341	1,663	17,456
Alaska---	86	71	61	53	38	45	40	49	56	62	51	55	667
Arkansas-	24	22	22	17	19	16	18	17	17	19	15	22	228
Colorado-	580	464	494	417	376	393	291	454	467	500	509	585	5,530
Illinois-	5,338	5,266	5,674	5,319	5,779	4,886	3,680	5,641	5,453	6,202	5,431	6,053	64,722
Iowa-----	65	66	61	91	84	67	65	89	81	83	75	76	903
Kansas---	78	92	127	124	139	103	43	108	120	105	107	167	1,313
Kentucky:													
Eastern	4,987	4,475	5,036	4,812	5,770	5,122	5,016	5,618	4,272	5,920	5,013	5,543	61,584
Western	4,434	4,143	3,952	3,224	3,865	3,333	3,283	3,978	4,434	4,448	3,672	4,700	47,466
Total	9,421	8,618	8,988	8,036	9,635	8,455	8,299	9,596	8,706	10,368	8,685	10,243	109,050
Maryland-	100	91	84	118	100	100	109	168	157	148	92	101	1,368
Missouri-	196	159	246	360	290	256	374	462	454	176	167	161	3,301
Montana:													
Bituminous	27	22	21	17	25	23	29	137	102	96	99	124	722
Lignite-	11	9	9	7	11	10	13	59	44	41	42	52	308
Total	38	31	30	24	36	33	42	196	146	137	141	176	1,030
New Mexico	301	271	292	340	430	347	317	389	484	634	308	358	4,471
North Dakota													
(Lignite)	442	490	418	286	316	312	311	272	336	521	456	544	4,704
Ohio-----	4,504	3,820	4,334	4,251	4,439	3,709	2,977	5,034	4,683	4,896	4,087	4,508	51,242
Oklahoma	90	103	135	100	155	129	126	207	191	179	183	240	1,838
Pennsylvania	6,689	6,317	6,873	6,854	6,862	6,315	4,956	6,379	6,800	7,475	6,479	6,632	78,631
Tennessee	699	594	618	702	737	673	614	724	664	755	649	653	8,082
Utah-----	479	435	473	400	388	387	216	348	378	297	392	464	4,657
Virginia-	3,077	2,641	3,028	2,879	3,065	2,774	2,416	3,091	2,96	3,560	2,900	3,163	35,555
Washington	8	7	6	7	3	3	3	3	3	5	4	6	58
W. Virginia	12,182	9,486	9,298	13,467	13,411	12,146	8,297	11,585	13,251	13,640	11,476	12,772	141,011
Wyoming--	552	363	324	254	277	239	251	302	366	504	508	662	4,602
Total	48,037	42,309	44,734	47,222	49,759	44,257	35,996	48,347	49,157	53,906	45,687	51,094	560,

1/ Figures are based principally upon railroad carloadings and shipments on the Allegheny and Monongahela Rivers, supplemented by direct reports from certain local sources. These estimates include coal both shipped by truck, and used at the mines, and the totals represent output for all mines producing 1,000 tons or more per year.

Figure 5-3E. Production of bituminous coal and lignite in the United States, in 1969, by districts, and by underground, strip, and auger mining

(Thousand short tons)

District		Underground	Strip	Auger	Total
1.	Eastern Pennsylvania -----	23,762	19,306	692	43,761
2.	Western Pennsylvania -----	34,670	4,760	79	39,508
3.	Northern West Virginia -----	35,343	5,453	190	40,986
4.	Ohio -----	18,625	31,014	1,602	51,242
5.	Michigan -----	-----	-----	-----	-----
6.	Panhandle -----	7,889	215	-----	8,104
7.	Southern Numbered 1 -----	31,772	3,688	678	36,138
8.	Southern Numbered 2 -----	122,933	20,182	13,048	156,161
9.	West Kentucky -----	19,834	27,618	14	47,466
10.	Illinois -----	30,082	34,640	-----	64,722
11.	Indiana -----	2,110	17,976	-----	20,086
12.	Iowa -----	368	534	-----	903
13.	Southeastern -----	10,251	8,739	39	19,029
14.	Arkansas-Oklahoma -----	176	580	9	766
15.	Southwestern -----	1	5,912	-----	5,913
16.	Northern Colorado -----	572	-----	-----	572
17.	Southern Colorado -----	3,878	1,915	-----	5,793
18.	New Mexico -----	1	3,636	-----	3,637
19.	Wyoming -----	122	4,481	-----	4,602
20.	Utah -----	4,657	-----	-----	4,657
21.	North-South Dakota -----	-----	4,704	-----	4,704
22.	Montana -----	35	995	-----	1,030
23.	Washington -----	53	672	-----	726
Total <u>y</u> -----		347,132	197,023	16,350	560,505

y Data may not add to totals shown because of independent rounding.

(From U. S. Bureau of Mines)

Figure 5-3F.

Number of mines, production, and value, at bituminous coal and lignite mines
in the United States, in 1969, by districts

District	Number of active mines	Production (thousand short tons)				Average value per ton ⁴
		Shipped by rail or water ¹	Shipped by truck	Used at mine ²	Total ³	
1. Eastern Pennsylvania ----	677	28,337	10,218	5,207	43,761	\$5.18
2. Western Pennsylvania ----	236	33,175	6,255	78	39,508	6.63
3. Northern West Virginia --	317	39,538	1,445	3	40,986	5.07
4. Ohio -----	322	32,675	13,909	4,657	51,242	4.10
5. Michigan -----	-----	-----	-----	-----	-----	-----
6. Panhandle -----	15	5,373	377	2,354	8,104	4.71
7. Southern Numbered 1 ----	451	35,473	472	192	36,138	7.02
8. Southern Numbered 2 ----	2,554	147,490	8,359	312	156,161	5.09
9. West Kentucky -----	80	40,682	6,782	1	47,466	3.52
10. Illinois -----	65	54,854	6,110	3,759	64,722	4.32
11. Indiana -----	38	14,626	2,884	2,576	20,086	4.13
12. Iowa -----	14	595	306	1	903	3.76
13. Southeastern -----	186	15,127	3,130	771	19,029	7.17
14. Arkansas-Oklahoma -----	13	763	3	-----	766	8.18
15. Southwestern -----	18	4,008	492	1,414	5,913	4.67
16. Northern Colorado -----	4	426	144	2	572	4.52
17. Southern Colorado -----	51	4,737	1,038	19	5,793	5.79
18. New Mexico -----	4	439	3,197	-----	3,637	2.58
19. Wyoming -----	12	1,702	48	2,852	4,602	3.36
20. Utah -----	21	4,240	393	24	4,657	6.31
21. North-South Dakota -----	20	2,974	378	1,352	4,704	1.85
22. Montana -----	12	992	37	-----	1,030	2.13
23. Washington -----	8	673	52	1	726	6.68
Total ³ -----	5,118	468,900	66,030	25,575	560,505	4.99

¹ Includes coal loaded at mine directly into railroad cars on river barges, hauled by trucks to railroad sidings, and hauled by trucks to waterways.

² Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine, and transported from mine to point of use by conveyor, tram, or pipeline.

³ Data may not add to totals shown because of independent rounding.

⁴ Value received or charged for coal, f.o.b. mine. Includes a value, estimated by producer, for coal not sold.

(From U. S. Bureau of Mines)

Indiana:													
Clay	-----	-----	5	1,176	-----	-----	472	702	1	1,176	\$4.42		
Davess	-----	-----	1	21	-----	-----	-----	21	-----	21	W		
Fountain	-----	-----	W	W	-----	-----	-----	W	-----	W	W		
Gibson	1	766	-----	-----	-----	705	60	1	766	W	W		
Greene	-----	-----	6	2,035	-----	1,811	224	-----	2,035	W	W		
Owen	-----	-----	W	W	-----	-----	-----	-----	-----	W	W		
Parke	-----	-----	1	2	-----	-----	-----	2	-----	2	4.00		
Pike	1	62	5	3,318	-----	3,013	366	1	3,380	W	W		
Spencer	-----	-----	W	W	-----	W	W	-----	-----	W	W		
Sullivan	2	1,180	4	3,124	-----	2,760	495	1,049	4,304	W	W		
Vigo	1	87	-----	-----	-----	-----	87	-----	87	W	W		
Warrick	1	15	7	8,201	-----	5,845	848	1,523	8,216	3.96			
Other counties	-----	-----	3	98	-----	20	77	-----	98	4.40			
Total 4	6	2,110	32	17,976	-----	14,626	2,884	2,576	20,086	\$4.13			
Kentucky--													
Western:													
Butler	1	36	6	163	-----	-----	198	-----	198	\$4.77			
Davess	-----	-----	1	912	-----	400	512	-----	912	3.00			
Henderson	3	118	-----	-----	-----	-----	117	1	118	3.75			
Hopkins	W	W	15	5,072	W	W	12,111	327	12,438	3.79			
Muhlenberg	7	4,367	15	17,054	-----	15,940	5,481	-----	21,420	3.47			
Ohio	W	W	W	W	-----	6,169	148	-----	6,317	3.45			
Union	W	W	-----	-----	-----	W	-----	-----	W	W			
Webster	W	W	W	W	-----	1,362	-----	-----	1,362	2.71			
Other Counties	18	15,313	13	4,418	1	14	4,700	-----	4,700	3.50			
Total 4	29	19,834	50	27,618	1	14	40,682	6,782	1	47,466	\$3.52		
Grand Total 4	1,028	64,336	163	37,503	150	7,211	98,069	10,920	60	109,049	\$4.14		
W Withheld to avoid disclosing individual company data; included with "Other counties".													
1	Includes coal loaded at mine directly into railroad cars or river barges, hauled by trucks to railroad sidings, and hauled by trucks to waterways.												
2	Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine, and transported from mine to point of use by conveyor, tram, or pipeline.												
3	Value received or charged for coal f.o.b. mine. Includes a value for coal not sold but used by producers, such as mine fuel and coal coked, as estimated by producers at average prices that might have been received if such coal had been sold commercially.												
4	Data may not add to totals shown because of independent rounding.												

(From U. S. Bureau of Mines)

Figure 5-3G

Production, shipments, and value at bituminous coal and lignite mines,
in the United States, in 1961, by states and countries

(Thousand short tons)

State and County	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Rail or water 1	Truck	Used at mine 2	Total	Average value per ton 3
Illinois:											
Adams	----	----	1	4	----	----	----	4	----	4	\$7.22
Christian	1	5,403	----	----	----	----	2,504	333	2,566	5,403	W
Douglas	1	913	----	----	----	----	493	420	-----	913	W
Franklin	4	8,558	----	----	----	----	8,533	25	1	8,558	W
Fulton	----	----	6	6,510	----	----	5,823	685	2	6,510	4.46
Gallatin	2	1,417	1	1,129	----	----	2,546	-----	-----	2,546	W
Grundy	----	----	1	240	----	----	139	101	-----	240	W
Jackson	----	----	2	101	----	----	101	-----	-----	101	W
Jefferson	3	4,654	----	----	----	----	4,480	155	19	4,654	W
Johnson	----	----	2	29	----	----	-----	29	-----	29	W
Kankakee	----	----	1	115	----	----	67	48	-----	115	W
Knox	----	----	1	1,773	----	----	1,702	71	-----	1,773	W
Mercer	1	15	1	6	----	----	-----	20	-----	21	W
Montgomery	2	3,264	----	----	----	----	1,719	393	1,152	3,264	W
Peoria	----	----	4	2,352	----	----	1,633	719	-----	2,352	W
Perry	----	----	4	10,428	----	----	10,205	217	5	10,428	3.67
Randolph	1	974	1	1,351	----	----	2,263	62	-----	2,325	W
St. Clair	2	519	2	5,256	----	----	4,197	1,579	-----	5,776	W
Saline	2	1,842	3	1,099	----	----	2,915	19	7	2,941	W
Stark	----	----	1	877	----	----	877	-----	-----	877	W
Vermillion	2	57	1	630	----	----	93	593	2	687	W
Washington	1	14	----	----	----	----	-----	14	-----	14	W
Will	----	----	1	673	----	----	391	283	-----	673	W
Williamson	6	2,451	4	2,066	----	----	4,174	339	4	4,517	4.68
Total 4	28	30,082	37	34,640	----	----	54,854	6,110	3,759	64,722	\$4.32

See footnotes at end of table.

Figure 5-3H.

Average value per ton, f.o.b. mines, of bituminous coal and lignite
produced in the United States, by States

State	1968				1969			
	Underground	Strip	Auger	Total	Underground	Strip	Auger	Total
Alabama -----	\$8.78	\$4.79	\$8.16	\$7.04	\$9.44	\$5.23	\$5.55	\$7.47
Alaska -----	---	6.00	---	6.00	---	6.54	---	6.54
Arkansas -----	7.82	7.35	---	7.47	8.45	7.71	---	7.90
Colorado -----	5.48	3.43	---	4.82	6.15	3.59	---	5.27
Illinois -----	4.14	3.92	3.25	4.01	4.43	4.23	---	4.32
Indiana -----	4.38	3.81	---	3.88	4.77	4.05	---	4.13
Iowa -----	3.83	3.71	---	3.75	3.77	3.75	---	3.76
Kansas -----	---	5.15	---	5.15	---	5.42	---	5.42
Kentucky -----	4.30	3.35	3.06	3.91	4.57	3.53	3.39	4.14
Maryland -----	4.25	3.64	2.00	3.67	3.77	4.01	2.30	3.85
Missouri -----	---	4.20	---	4.20	4.33	4.33	---	4.33
Montana:								
Bituminous -----	8.53	1.86	---	3.12	9.17	1.83	---	2.18
Lignite -----	---	1.89	---	1.89	---	2.03	---	2.03
Total -----	8.53	1.88	---	2.34	9.17	1.89	---	2.13
New Mexico -----	8.38	2.66	---	3.94	8.37	2.58	---	3.66
North Dakota (lignite) -----	---	1.78	---	1.78	---	1.85	---	1.85
Ohio -----	4.46	3.72	3.39	3.96	4.65	3.79	3.63	4.10
Oklahoma -----	6.46	5.85	8.16	5.88	7.83	5.65	8.43	5.80
Pennsylvania -----	5.97	3.84	4.05	5.37	6.53	4.24	4.04	5.87
Tennessee -----	3.66	3.61	3.60	3.64	3.94	3.65	3.27	3.80
Utah -----	5.77	---	---	5.77	6.31	---	---	6.31
Virginia -----	5.07	3.55	3.48	4.84	5.73	3.64	3.43	5.42
Washington -----	9.07	2.91	---	4.63	8.40	6.26	---	8.21
Virginia -----	5.46	4.31	4.06	5.32	5.90	4.77	4.61	5.73
Mining -----	6.34	3.06	---	3.16	6.40	3.27	---	3.36
Total -----	5.22	3.75	3.53	4.67	5.62	3.98	3.81	4.99

(From U. S. Bureau of Mines)

U.S. BUREAU OF MINES

Production and average value per ton, f.o.b. mines, of bituminous coal and lignite sold in open market and not sold in open market, in 1969, by States

(Thousand short tons)		Production			Average value per ton, f.o.b. mines		
		Sold in open market	Not sold in open market	Total $\frac{1}{2}$	Sold in open market	Not sold in open market	Total
Alabama-----		10,267	7,188	17,456	\$6.03	\$9.52	\$7.47
Alaska-----		667	---	667	6.54	---	6.54
Arkansas-----		228	---	228	7.90	---	7.90
Colorado-----		4,024	1,506	5,530	4.41	7.56	5.27
Illinois-----		63,891	831	64,722	4.30	5.62	4.32
Indiana-----		20,086	---	20,086	4.13	---	4.13
Iowa-----		903	---	903	3.76	---	3.76
Kansas-----		1,313	---	1,313	5.42	---	5.42
Kentucky-----		101,574	7,475	109,049	3.96	6.56	4.14
Maryland-----		1,368	---	1,368	3.85	---	3.85
Missouri-----		3,301	---	3,301	4.33	---	4.33
Montana:							
Bituminous-----		721	1	722	2.18	2.02	2.18
Lignite-----		308	---	308	2.03	5.60	2.03
Total $\frac{1}{2}$ -----		1,029	1	1,030	2.14	2.05	2.13
New Mexico-----		3,660	812	4,471	2.59	8.50	3.66
North Dakota (lignite)-----		4,580	125	4,704	1.84	2.00	1.85
Ohio-----		44,879	6,363	51,242	4.14	3.82	4.10
Oklahoma-----		1,838	---	1,838	5.80	---	5.80
Pennsylvania-----		49,689	28,943	78,631	4.89	7.56	5.87
Tennessee-----		8,082	---	8,082	3.80	---	3.80
Utah-----		2,614	2,044	4,657	4.77	8.28	6.31
Virginia-----		34,856	699	35,555	5.39	7.02	5.42
Washington-----		58	---	58	8.21	---	8.21
West Virginia-----		121,231	19,780	141,011	5.53	6.95	5.73
Wyoming-----		2,545	2,057	4,602	3.84	2.75	3.36
Total $\frac{1}{2}$ -----		482,682	77,823	560,505	4.65	7.05	4.99

1/ Data may not add to totals shown because of independent rounding.

Figure 5-3J.

Mechanical cleaning at bituminous coal and lignite mines in the
United States, in 1969, by States

(Thousand short tons)

State	Total production	Mechanical cleaning			
		Number of cleaning plants	Raw Coal	Cleaned coal	Refuse
Alabama -----	17,456	22	19,012	11,498	7,513
Alaska -----	667	3	64	34	30
Arkansas -----	228	1	53	49	4
Colorado -----	5,530	4	1,960	1,701	259
Illinois -----	64,722	43	68,190	54,911	13,280
Indiana -----	20,086	11	21,435	16,570	4,862
Kansas -----	1,313	3	1,893	1,308	585
Kentucky -----	109,049	52	58,744	47,149	11,595
Missouri -----	3,301	4	2,321	1,716	605
New Mexico -----	4,471	1	1,023	824	200
Ohio -----	51,242	19	20,610	15,567	5,042
Oklahoma -----	1,838	4	479	338	141
Pennsylvania -----	78,631	77	66,468	50,755	15,712
Tennessee -----	8,082	5	2,048	1,581	468
Utah -----	4,657	6	3,649	3,157	492
Virginia -----	35,555	33	27,233	21,176	6,057
Washington -----	58	3	65	53	11
West Virginia -----	141,011	143	140,033	106,297	33,735
Wyoming -----	4,602	1	78	77	2
Other States ^{1/} -----	8,005	-----	-----	-----	-----
Total ^{2/} -----	560,505	435	435,356	334,761	100,593

^{1/} Includes Iowa, Maryland, and bituminous coal and lignite from Montana, and North Dakota.

^{2/} Data may not add to totals shown because of independent rounding.

(From U. S. Bureau of Mines)

Figure 5-3K.

Consumption of bituminous coal and lignite, by consumer class, with retail deliveries
in the United States

Year and month	Electric power utilities ^{1/}	Bunker, lake vessel and foreign ^{2/}	(Thousand short tons) Manufacturing and mining industries					Retail deliveries to other consumers ^{5/}	Total of classes shown ^{6/}
			Beehive coke plants	Oven coke plants	Steel and rolling mills ^{3/}	Cement mills	Other manufac- turing and mining industries ^{4/}		
1965 -----	242,729	655	2,693	92,086	7,466	8,873	85,614	19,048	459,164
1966 -----	264,202	609	2,369	93,523	7,117	9,149	89,332	19,965	486,266
1967 -----	271,784	467	1,372	90,900	6,330	8,922	83,542	17,099	480,416
1968:									
January -----	26,646	1	120	7,975	645	754	8,423	2,780	47,344
February -----	25,115	-----	113	7,634	611	803	7,867	2,380	44,523
March -----	24,346	3	131	8,082	571	702	7,623	1,730	43,188
April -----	21,929	43	134	7,870	492	754	6,739	773	38,734
May -----	22,574	57	135	8,122	476	856	6,584	471	39,275
June -----	23,209	49	118	7,840	407	747	6,011	475	38,856
July -----	25,126	46	103	7,835	381	741	5,819	465	40,516
August -----	26,530	61	97	7,198	336	748	5,807	681	41,458
September -----	22,850	54	85	6,561	325	771	5,882	943	37,471
October -----	23,764	48	76	6,524	390	777	6,700	1,357	39,636
November -----	24,781	41	78	6,632	449	828	7,209	1,339	41,357
December -----	27,869	14	78	7,224	574	910	7,973	1,830	46,472
Total -----	294,739	417	1,268	89,497	5,657	9,391	82,637	15,224	498,830
1969:									
January -----	29,041	1	73	7,379	633	712	8,132	2,597	48,568
February -----	24,771	-----	70	6,937	563	710	7,246	2,007	42,304
March -----	26,304	3	86	7,579	608	880	7,442	1,509	44,411
April -----	22,383	28	97	7,581	477	810	6,705	530	38,611
May -----	23,142	36	88	7,866	411	771	6,316	374	39,004
June -----	24,391	31	87	7,656	374	731	5,861	335	39,466
July -----	27,173	41	78	7,755	348	681	5,557	442	42,074
August -----	26,794	40	111	7,729	332	711	5,573	538	41,828
September -----	24,544	39	120	7,594	361	695	5,545	748	39,646
October -----	25,226	44	111	7,981	414	770	6,122	1,074	41,742
November -----	25,735	36	105	7,664	476	807	6,477	1,122	42,422
December -----	28,957	14	132	8,022	563	853	7,267	1,390	47,198
Total -----	308,461	313	1,138	91,743	5,560	9,131	78,243	12,666	507,275

^{1/} Federal Power Commission.

^{2/} Bureau of the Census, U.S. Department of Commerce, Ore and Coal Exchange.

^{3/} Estimates based upon reports collected from a selected list of representative steel and rolling mills.

^{4/} Estimates based upon reports collected from a selected list of representative manufacturing plants.

^{5/} Estimates based upon reports collected from a selected list of representative retailers. Includes some coal shipped by truck from mine to final destination.

^{6/} The total of classes shown approximates total consumption. The calculation of consumption from production, imports, exports, and changes in stocks is not as accurate as the "Total of classes shown" because certain significant items of stocks are not included in yearend stocks. These items are stocks on Lake and Tidewater docks, stocks at other intermediate storage piles between mine and consumer, and coal in transit.

(From U. S. Bureau of Mines)

flood plains and towns and in areas of minor oil production. A statement in their report says, "The tonnage figures presented in this report are not, and were not meant to be, an estimate of the total coal resources."

I believe the TVA tonnage figures present a reasonable picture of the coal reserves about which we have a great deal of information. They do not, however, show the coal that should be inferred and considered reserves. This includes some of the coal left out by TVA that has been proven mineable, such as under flood plains and near oil test holes, some vast areas of irregular coal beds 14 to 24 inches or even thicker, and the coals in the lower part of the geologic section that have not been prospected at depth but are known to be widespread and reach mineable thickness from scattered records.

I believe the addition of these known reserves to those proven by the TVA studies would almost double the reserves to 25 billion tons. Detailed reserve studies conducted by acceptable standards might permit a proved reserve approaching the value of 38 billion inferred by the U.S. Geological Survey projection.

At the present time, the U.S. Geological Survey, in cooperation with the Kentucky Geological Survey, is engaged in a geological mapping program of the state. These 1:24,000 scale geological maps are presently being published but are incomplete. While not intended for reserves studies, it is presumed that this mapping can be used to refine coal reserves estimates locally.

The principal coals in West Kentucky are the No. 9, No. 11, No. 12 and No. 14 coals.

Reserves estimates completed to date have given only general attention to the sulfur content of the coal.

The limited quantity of low sulfur (1.0%) believed present within the MWCF is emphasized by a Federal Power Commission staff study. The largest reserves of 1.0% or less sulfur coal is found in West Virginia (Figure 5-10).

De Carlo (1966) evaluated remaining bituminous coal reserves in the MWCF by sulfur content, i.e., low (1.0% or less), medium (1.1 - 3.0%) and high (3.1% or more) sulfur coal. (Figure 5-11). A total of 207 billion tons were classified. Sheridan (1968) summarized West Kentucky coal reserves by county and sulfur content (Figure 5-11A and 5-11B) after the Ford, Bacon and Davis report and indicated 500 million tons of reserves with a sulfur content of 2.0% or less. Selected coal quality data were prepared in 1967 by Weir and Company (Figure 5-12) which included attention to forms of sulfur present (Figure 5-13). The De Carlo (1966) data were altered for Illinois in NAPCA Document AP-52 (1969).

The most pertinent study to date by Gluskoter and Simon (1968) described low sulfur coal in Illinois where sufficient data for mapping were available.

Three principal areas of relatively low sulfur coal have been described by Gluskoter and Simon (1968). The first lies in Jefferson, Franklin and Williamson Counties, and contains a total reserve in the ground of approximately 1 billion tons of No. 6 coal with sulfur 1 to 2.5% and estimated to average 1.5%. It is the source of most of the Illinois coal not being used in blends to produce metallurgical coke.

A second area of No. 6 coal lying in St. Clair and Madison Counties is comparable in sulfur content to the first area. Tests indicate that the coal in this area is less suitable in blends for metallurgical coke since only relatively small percentages can be used. About 650 million tons lie within the area.

The third area, primarily in Saline, Franklin and Williamson Counties, reportedly contains about 1 billion tons of No. 5 coal that is suitable for use in blends for coking but carries sulfur ranging from 1 to 3% and averaging 2.25%. An Illinois State Geological Survey publication (Circular 431) reported low sulfur coal through counties to the northeast; published analyses were, however, unavailable.

5.3 RESERVES DATA SUMMARY

5.3.1 Area Data Summary

As a result of the analysis previously described, it was estimated that total available reserves of coal in place in the MWCF amounted to 193,700 million tons in Illinois, 50,700 million tons in Indiana and 16,900 million tons in Western Kentucky for a total of 261,300 million tons (Figure 5-14).

Reserves amounting to 194 billion tons in Illinois contrast with nearly 148 billion tons as computed by the Illinois State Geological Survey. While Illinois State Geological Survey estimates are presumably conservative, these computations are based on detailed geological mapping and intensive geological analysis. Some explanation for this variation is, therefore, warranted.

It should be noted that an overall minimum thickness of 24 inches was used for reserves estimates in this study while Illinois State Geological Survey estimates have been based on a thickness of 28 inches for deep coal and 18 inches for strip coal.

In addition, the Illinois State Geological Survey has calculated some reserves assuming a minimum thickness of 28 inches, for all Class IIB (weakly indicated) reserves although in some areas a greater thickness could have been estimated. Had greater thickness values been used, reserves in excess of 146 billion tons could have resulted.

Such variations in the computational (thickness) base have introduced reserves tonnages in excess of State estimates; in addition, the study team extrapolated thickness data across township areas where data was generally limited, i.e., areas which in some cases were not mapped by the geological Survey. Using a methodology for geological mapping based on mean thickness data, extrapolated over large areas, has contributed largely to the additional reserves amounting to 46 billion tons. Given sufficient time and the addition of new data, e.g., diamond drill records, statewide reserves defined in

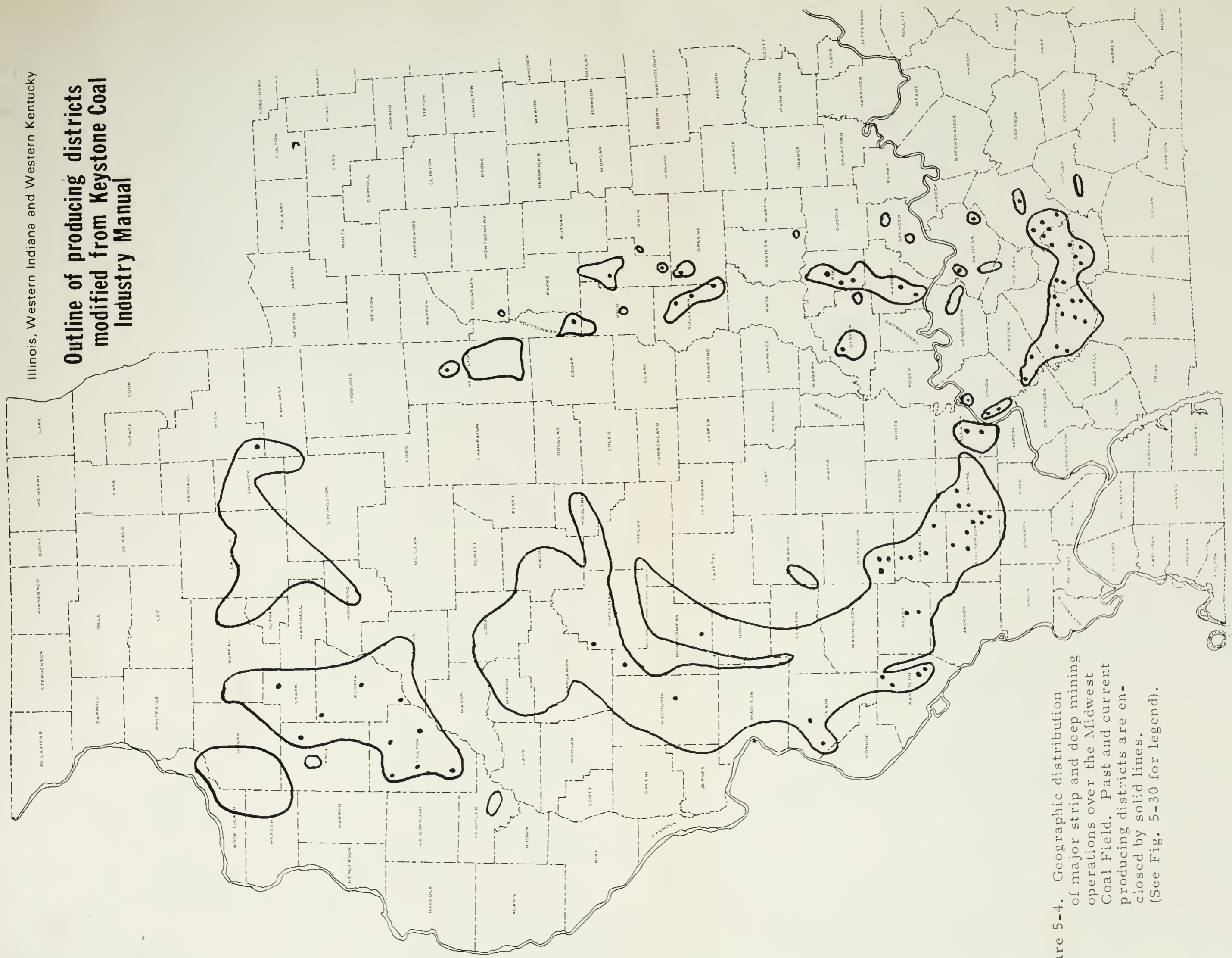


Figure 5-4. Geographic distribution of major strip and deep mining operations over the Midwest Coal Field. Past and current producing districts are enclosed by solid lines. (See Fig. 5-30 for legend).

Coal Bed	1-A Proved	1-B Probable	H-A Strongly indicated	H-B Weakly indicated	Total	Mined- out area (in sq.mi.)
Trowbridge	8,396	7,873			16,269	
Friendsville	-	24,449	70,018	5,388	99,855	.14
Danville (Sparland) No. 7	1,003,028	3,413,502	2,924,154	499,698	7,840,381	18.23
Jamestown	42,147	191,363	367,425		600,934	
Herrin No. 6 (includes Grape Creek)	12,299,737	21,100,547	25,143,881	4,093,391	62,637,556	672.93
Harrisburg (Springfield No. 5)	4,168,131	9,593,325	19,776,703	4,971,819	38,509,978	261.55
Sumnum No. 4	51,592	62,359	67,585		181,537	.77
Indiana IV	11,946	58,072	61,024		131,042	
LaSalle (Colchester) No. 2	1,359,365	3,622,676	6,216,399	6,287,748	17,486,188	103.52
Dekoven	92,150	845,075	1,548,149		2,485,374	.03
Indiana III	167,452	687,898	965,550		1,820,900	
Davis-Wiley	123,448	1,061,644	1,982,935	364,056	3,432,084	.10
Campbell Hill	8,833				8,833	
Stonefort	4-540				4,540	
Bald Hill	27,245	39,033	5,028	1,229	72,535	
Murphysboro	34,064	86,016	147,370	124,343	391,794	8.55
Rock Island No. 1	111,286	65,230	89,904	6,539	268,960	11.73
Assumption-Litchfield	27,794	265,473	1,010,768		1,304,035	.44
Willis	6,892				6,892	
Makanda	1,962				1,962	
Coals of unknown correlation lower than No. 6	21,186		6,375		27,561	
TOTAL	19,571,192	41,124,535	60,279,271	16,354,211	137,329,208	1,007.99

Figure 5-5a Summary By Coal Bed: Four Categories of Reserves and Mined-out Area (In Thousands of tons)

Source	Date	Billions of Tons in the ground	Minimum Thickness(in.)
DeWolf	1908	137.0	36
Campbell and Parker	1909	240.0	?
Bement	1910	201.5	12
Campbell	1913	201.5	14
Bement	1929	201.4	36
Averitt and Berryhill	1950	165.6	?
*Fort, Bacon, and Davis	1951	49.6	28 (underground)
			12 (strippable)
Cady	1952	137.3	28
Simon and Smith	1968	140.0	28 (underground)
			18 (strippable)
*Minability factors considered in addition to presence of coal.			

Figure 5-5B - Principal Estimates of Illinois Coal Reserves from Simon and Smith (1969).

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summum (No. 4)	Colchester (No. 2)
Adams					625,241
Bond		2,451,950	299,867		2,092
Brown					385,689
Bureau	424,110	649,427			1,221,789
Calhoun		55,884	49,049		15,015
Cass					452,957
Champaign	181,884				
Christian	61,454	3,556,511	1,336,119		
Clark	316,655	11,848	511,149		
Clay		916,819	702,311		
Clinton		3,236,433	552,248		
Coles	312,112		44,046		
Crawford	211,152	571,817	929,166		
Cumberland		162,249	171,260		
De Witt			173,619		
Douglas	726,829		11,011		
Edgar	950,564	721,363	441,330		
Edwards		684,316	449,545**		
Effingham		622,072	1,164,351		
Fayette	296,023	2,773,953	159,646		
Franklin					
Fulton		2,213,231	2,031,768**	5,448	1,319,301
Gallatin	58,882	255,218	785,188		
Greene		1,151,820	1,301,483**	25,199	583,496
Grundy		49,556		10,638	344,353
Hamilton		33,832			
Hancock		2,611,967	2,143,324**		29,829
Hardin					
Henderson					53,111
Henry	58,878	260,289			668,819

Figure 5-6.

From data compiled by Illinois State Geological Survey

DeKoven	Davis	Rock Island (No. 1)	Misc. Coals	Total	Percent Strippable
			2,472	625,241 2,756,381 385,689 2,295,326 15,015 557,890 181,884 5,040,744 1,219,537 1,619,130	99.0 100.0 19.7 100.0 43.8
			86,660 379,885	3,788,681 356,158 2,405,921 337,354 173,619 747,903	
			693,786 3,845 10,063 878,904	2,992,161 1,133,861 1,786,423 3,229,622	
362,147	507,878		62,040	5,177,064	87.2
651,697	858,038	5,458	6,892	2,429,495 3,969,930 658,251 888,823 4,764,184 29,829 3,598 53,111 1,064,646	5.9 91.2 40.0
3,557	5,336				100.0
1,177	2,421				100.0 58.3
		76,660			

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summa (No. 4)	Colchester (No. 2)
Jackson		236,551	218,494		197,789
Jasper		1,861,661	1,415,200		87,052
Jefferson		2,848,713	2,003,784**		803,634
Jersey	10,482	71,256			1,452,560
Kankakee		36,055			
Knox	2,523	310,691	649,929		
La Salle	489,782	217,346			
Lawrence	223,427	1,186,698	985,024		
Livingston	267,427	370,566			2,351,608
Logan			2,589,660		
McDonough					
McLean	603,370		316,337		584,339
Macon		162,928	1,689,960		296,406
Macoupin	15,510	3,935,453	43,026	32,328	1,632,416
Madison		1,943,928			660,331
Marion		1,218,246	748,495		
Marshall	337,384	9,749			858,033
Mason			23,271		
Menard			2,054,365		23,775
Mercer					17,859
Monroe		13,676	4,970		
Montgomery	24,972	3,743,720	523,812	85,909	558,844
Morgan		621,765	18,021	22,531	1,322,351
Moultrie		355,524			
Peoria	282,537	1,070,432	1,321,268		440,025
Perry		2,294,358	440,324		
Piatt			10,698		
Pike					
Putnam	197,035	78,876			
Randolph		516,396	185,965		144,401
Richland					467,893
Rock Island		1,191,832	932,509		
St. Clair		2,536,106	621,565		
Saline	78,422	1,361,979	1,139,573**	6,835	7,768
Sangamon		2,194,896	3,373,581		280,804

Figure 5-6. (Continued).

DeKoven	Davis	Rock Island (No. 1)	Misc. Coals	Total	Percent Stripplable
			257,749	712,794 3,276,861 4,852,497 279,527 123,107 1,824,583 2,159,688 2,950,929 2,989,601 2,589,660	54.8 78.9 21.9 86.8 12.9 1.6
		57,806	555,780		
			697,334 8,015	584,339 1,216,113 1,852,888 6,482,430 2,616,979 1,966,741 1,205,166 23,271 2,078,140 87,107	100.0 4.2 23.5 9.6
		69,248			80.4
			513,415	18,646 5,584,025 1,984,668 355,524 3,114,262 2,734,682 10,698 144,401 743,804 702,361	36.4 41.7 69.8 40.4
					100.0
					64.7
		62,133		2,124,341 62,133	67.5
			3,178 4,086	3,157,671 4,438,591 5,853,367	39.5 12.2
698,270	1,142,516				

REMAINING COAL RESERVES IN ILLINOIS BY COUNTY AND COAL SEAM (thousands of tons)

County	Danville (No. 7)	Herrin (No. 6)	Harrisburg- Springfield (No. 5)	Summum (No. 4)	Colchester (No. 2)
Schuyler			113,393		606,151
Scott	125,267	6,120			253,499
Shelby	57,703	1,183,577	304,861		
Stark	4,152	442,507			25,781
Tazewell		69,687	129,386		202,528
Vermilion	1,712,155	702,569			
Wabash		575,908	513,063**		
Warren			650,598		369,414
Washington		3,462,823			
Wayne		2,349,795	1,700,575**		
White		2,364,131	2,279,710**		
Will					
Williamson	22,610	823,044	920,669**	2,648	
Woodford	38,560		144,770		990,850
	8,091,861	65,360,117	41,323,335	191,586	20,877,177

* Totals include coal seams 28 inches or more thick in all classes of reliability as defined in Reference 2. Strippable coals include coals 18 inches or more thick and under 150 feet or less overburden. These totals do not include coal produced or rendered unminable since the date of each resource study. Data are compiled from Illinois State Geological Survey publications, References numbered 2, 15, 19, 20, 21, 22, 23 30, 33, 38.

** Reserve estimates for the No. 5 Coal in all or part of these counties have been made using different bases than reserve studies cited above and are not included in this list. See Reference 46.

Figure 5-6. (Continued).

DeKoven	Davis	Rock Island (No. 1)	Misc. Coals	Total	Percent Strippable
			18,799	719,544 259,619 1,632,504 525,991 405,753	100.0 87.2 100.0 36.9
		39,000	44,521 99,855	2,459,245 1,188,826 408,414 4,113,421 4,050,370 4,674,868 41,347 3,323,867 1,174,180	98.5
13,823	17,204				52.2
754,702	634,300		165,894		19.6
2,485,373	3,432,084	310,305	4,493,173	146,565,014	

Source	Basis of estimate			Reserves
	Class	Minimum average thickness	Weight per acre-foot (tons)	
Ashley, 1909	Recoverable in part; original in part.	Generally less than 14 inches.	780 to 1,560	¹ 46,864,000
Campbell, 1913	Original	14 inches	1,770	² 53,051,000
Present report, 1953	Original	14 inches	1,800	37,293,079

¹ Part of this tonnage is recoverable reserves only.

² Derived by extrapolation from 1909 estimates by Ashley.

Figure 5-7 Comparison of estimates of coal reserves in Indiana (in thousands of short tons)
(from Spencer, 1953)

County	Original reserves				Mined and lost in mining to January 1, 1951		
	Coal 14-28 in. thick	Coal 28-42 in. thick	Coal more than 42 in. thick	Total	Coal 14-28 in. thick	Coal 28-42 in. thick	Coal more than 42 in. thick
Clay	7,840	19,970	393,724	421,534	403	480	53,653
Daviess	203,406	316,718	348,264	868,388	560	3,777	6,066
Dubois	51,341	95,805	27,132	174,278	---	---	---
Gibson	244,697	781,718	3,548,943	4,575,358	---	72	87,888
Greene	28,413	27,019	926,697	982,129	253	1,301	157,404
Knox	588,878	1,404,618	3,655,962	5,649,458	---	361	157,736
Martin	73,866	98,759	23,989	196,614	---	---	---
Owen	6,512	21,686	3,587	31,785	101	657	606
Parke	---	167	300,150	300,317	---	---	24,735
Perry	25,488	27,374	6,384	59,206	---	---	---
Pike	61,540	143,141	974,238	1,178,919	71	749	145,127
Posey	118,359	712,628	4,562,454	5,393,441	---	---	---
Spencer	79,666	119,469	51,237	250,372	1,093	1,993	383
Sullivan	432,612	2,508,858	4,684,325	7,625,795	107	19,768	196,469
Vanderburgh	209,614	496,688	1,479,627	2,185,929	---	---	19,006
Vermillion	9,983	15,920	1,196,738	1,222,641	---	807	118,407
Vigo	118,628	601,054	3,771,835	4,491,517	---	8,461	356,602
Warrick	79,749	240,797	1,364,852	1,685,398	3,494	638	118,075
Total	2,340,552	7,632,389	27,320,138	37,293,079	6,082	39,064	1,442,157
							1,487,303

Assuming 80 percent recoverability for strippable coal and 50 percent recoverability for nonstrippable coal.

Figure 5-8

Remaining reserves as of January 1, 1951				Recoverable reserves as of January 1, 1951 ¹		
Coal 14-28 in. thick	Coal 28-42 in. thick	Coal more than 42 in. thick	Total	Coal 14-28 in. thick	Coal 28-42 in. thick	Coal more than 42 in. thick
7,437	19,490	340,071	366,988	5,944	15,559	217,232
202,846	312,941	342,198	857,985	120,734	190,675	204,909
51,341	95,805	27,132	174,278	25,671	47,902	13,566
244,697	781,646	3,461,055	4,487,398	126,935	406,726	1,753,645
28,160	25,718	769,293	823,171	22,526	20,575	483,246
588,878	1,404,257	3,498,226	5,491,361	299,776	707,174	1,762,818
73,866	98,759	23,989	196,614	36,932	49,381	11,994
6,411	21,029	2,981	30,421	5,127	16,824	2,385
---	167	275,415	275,582	---	84	161,386
25,448	27,374	6,384	59,206	12,725	13,687	3,191
61,469	142,392	829,111	1,032,972	32,195	78,705	497,596
118,359	712,628	4,562,454	5,393,441	59,178	356,315	2,281,227
78,573	117,476	50,854	246,903	51,957	75,716	32,614
432,505	2,489,090	4,487,856	7,409,451	217,195	1,299,083	2,316,265
209,614	496,688	1,460,621	2,166,923	104,808	248,343	730,310
9,983	15,113	1,078,331	1,103,427	5,002	7,820	555,143
118,628	592,593	3,415,233	4,126,454	60,123	327,376	1,778,691
76,255	240,159	1,246,777	1,563,191	46,097	142,488	735,017
2,334,470	7,593,325	25,877,981	35,805,776	1,232,925	4,004,433	13,541,235
						18,778,593

Summary of Coal reserves in Indiana by counties (in thousands of short tons),
from Spencer, 1953

COAL RESERVES OF INDIANA

SUMMARY BY COUNTY

JANUARY 1, 1965

(in thousands of short tons)

COUNTY	TOTAL RESERVES			RECOVERABLE RESERVES		
	<u>Strippable</u>	<u>Deep</u>	<u>Total</u>	<u>Strippable</u>	<u>Deep</u>	<u>Total</u>
Clay	404,119	504,731	908,850	323,296	252,366	575,662
Daviess	171,301	239,004	410,305	137,041	119,502	256,543
Dubois	5,997	7,956	13,953	4,803	3,981	8,784
Fountain and Warren	40,717	7,204	47,921	32,574	3,603	36,177
Gibson	---	4,473,852	4,473,852	---	2,236,927	2,236,927
Greene	267,198	456,795	723,993	213,757	228,298	442,055
Knox	177,856	4,482,971	4,660,827	142,285	2,241,486	2,383,771
Martin	103,464	22	103,486	82,771	11	82,782
Owen	63,489	---	63,489	50,791	---	50,791
Parke	11,964	59,004	70,968	9,564	29,402	38,966
Perry	---	56,400	56,400	---	28,200	28,200
Pike	311,313	740,936	1,052,249	249,050	370,469	619,519
Posey	---	5,740,781	5,740,781	---	2,870,391	2,870,391
Spencer	66,368	---	66,368	53,097	---	53,097
Sullivan	392,454	6,981,147	7,373,601	313,964	3,490,574	3,804,538
Vanderburgh	---	2,166,909	2,166,909	---	1,083,454	1,083,454
Vermillion	57,492	588,706	646,198	44,712	295,407	340,119
Vigo	319,476	2,898,412	3,217,888	255,580	1,449,210	1,704,790
Warrick	405,019	1,034,808	1,439,827	324,014	517,404	841,418
TOTAL INDIANA	2,798,227	30,439,638	33,237,865	2,237,299	15,220,685	17,457,984

Figure 5-9. Summary of coal reserves by county as of January 1, 1965
Weir and Hutchinson, 1970.

	Geological Reserves in Place <u>Billion Tons</u>
West Virginia	47.5
East Kentucky	22.1
Virginia	8.1
Alabama	2.1
Pennsylvania	1.2
Other	<u>1.0</u>
Total	82.0

Figure 5-10 One Percent or Less Bituminous Sulfur Coals East of the Mississippi River (after Federal Power Commission 1968.)

Sulphur Content, percent										
State	0.7 or less	0.81-1.0	1.1-1.5	1.6-2.0	2.1-2.5	2.6-3.0	3.1-3.5	3.6-4.0	Over 4.0	TOTAL
Illinois			1808.0		139.5	17,871.9	36,264.0	62,130.0	20,542.6	139,756.0
Indiana	197.5	173.0	3645.2	4248.8	3543.4	4110.5	10,872.8	5105.9	2944.0	34,841.1
West Kentucky			1119.6	162.0	336.3	3793.6	12,759.3	13,643.3	5081.3	36,895.4
TOTAL										207,125.6

Figure 5-11 Estimated remaining bituminous reserves by sulfur content
(Million Short Tons) from DeCarlo, 1966
*Modified in 1969. (See NAPCA AP-52, 1969)

County	Sulfur content (percent)				Total ^{2/}
	2.0 or less	2.1-3.0	3.1-4.0	More than 4.0	
Hopkins	--	116.4	2201.3	--	2317.7
Webster	280.0	--	1361.8	--	1641.8
Muhlenberg	--	48.8	1072.4	463.8	1585.0
Union	--	52.7	1069.5	--	1122.2
Henderson	144.9	--	842.9	--	987.8
Ohio	--	526.0	--	376.9	902.9
McLean	--	25.4	118.0	130.9	274.3
Daviess	--	124.2	--	--	124.2
Christian	44.4	--	--	--	44.4
Butler	--	25.7	--	--	25.7
TOTAL	469.3	919.2	6665.9	971.6	9026.0

^{2/} Reserves as estimated by Ford, Bacon, and Davis, Inc., 1951

Figure 5 - 11A Estimated remaining bituminous-coal reserves in West Kentucky on January 1, 1966, by sulfur class (Million Short Tons)

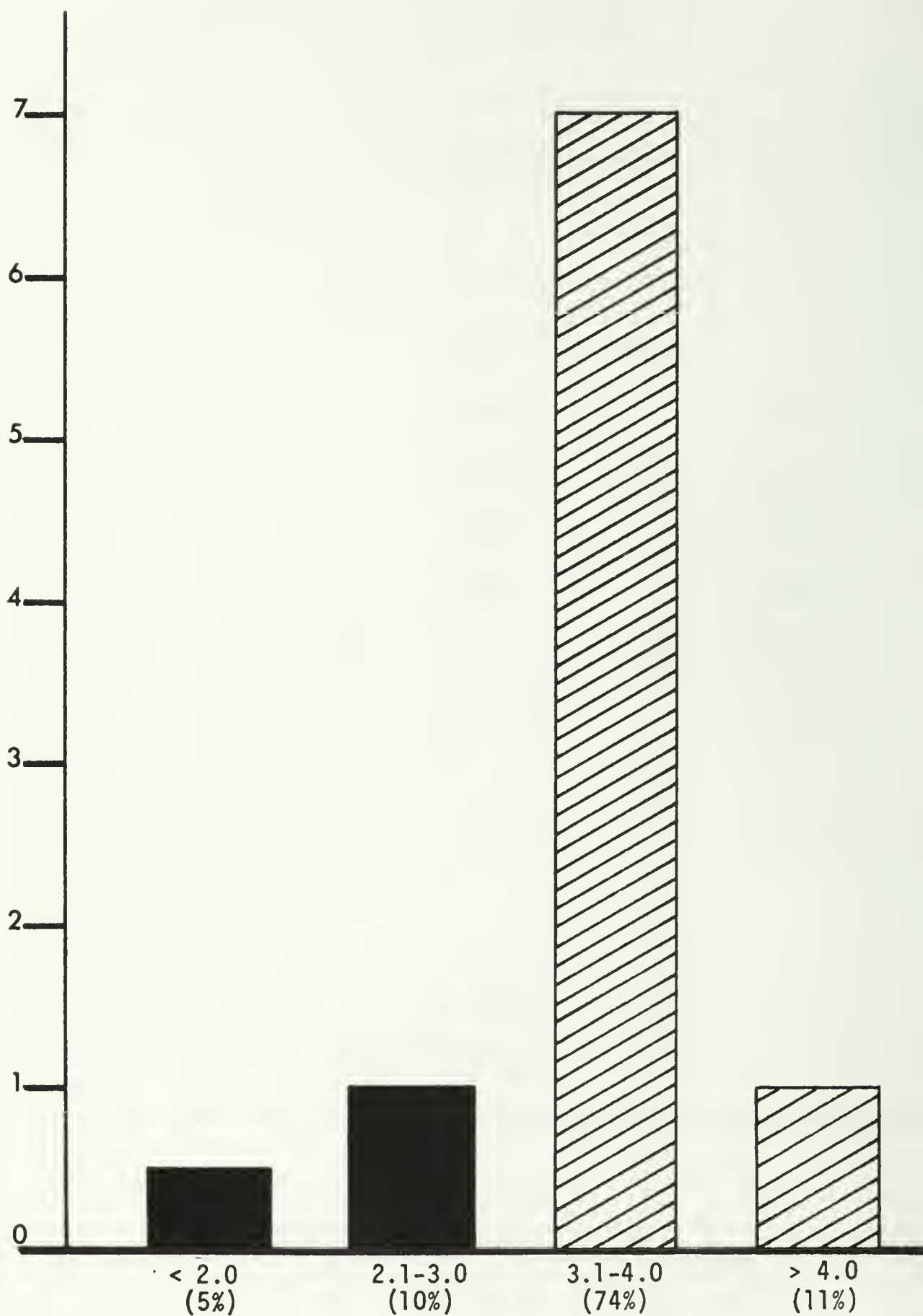


Figure 5-11B Sulfur distribution in 9.0 billion classified reserves in West Kentucky. From Sheridan (1968).

Name of Coal Bed/ Area	Total Moisture	Total Sulphur	Ash	Volatile Matter	Fixed Carbon	BTU's (as received)
<u>Northern Illinois</u>						
Colchester No. 2	15.4-17.1	1.6-5.2	5.9-10.4	40.7-45.4	46.0-53.2	11,000-11,340
Herrin No. 6	11.9-14.0	3.5-5.4	9.2-12.8	40.0-45.2	44.0-46.3	10,700-11,250
Danville No. 7	14.2-15.3	3.2-4.7	12.1-16.7	41.0-43.7	41.5-45.0	10,050-10,910
<u>Western Illinois</u>						
Rock Island No. 1	11.2-16.6	4.8-6.5	9.6-12.1	40.0-45.0	40.3-46.2	10,620-11,470
No. 5 Seam	14.5-15.4	2.7-4.0	11.0-13.0	41.0-42.4	45.0-46.9	10,460-10,740
No. 6 Seam	15.0-18.3	3.5-6.4	10.6-13.8	39.0-45.0	42.0-50.0	9,750-10,680
<u>Springfield</u>						
No. 5 Seam	13.4-15.3	3.3-4.9	10.7-13.0	41.7-42.6	45.2-47.3	10,640-10,750
No. 6 Seam	7.0-13.9	4.0-4.8	11.0-13.6	41.0-45.0	45.0-47.-	10,700-11,800
<u>Danville</u>						
No. 7 Seam	14.2-15.3	3.2-4.7	12.1-16.6	41.5-42.7	41.7-45.6	10,050-10,910
<u>Southwestern</u>						
No. 5 Seam	8.3-10.7	3.1-4.5	11.3-12.4	39.4-40.7	46.5-49.8	11,150-11,670
No. 6 Seam	10.0-13.2	3.7-5.0	11.2-12.0	41.7-42.8	45.3-46.6	10,700-11,000
<u>Southern Illinois</u>						
No. 5 Seam	4.2-7.0	3.0-4.1	9.0-11.0	35.5-37.0	48.5-52.0	11,890-12,730
No. 6 Seam	4.3-9.4	0.9-4.0	8.5-11.5	33.5-36.5	40.7-49.6	11,450-12,550
DeKoven-Davis	4.9-6.0	3.5-5.2	8.5-13.6	35.7-37.0	45.8-50.2	12,000-12,600
<u>Indiana</u>						
Coal III	11.0-13.7	0.9-7.6	8.9-13.8	40.6-44.8	45.0-47.5	10,500-12,530
Coal IV	12.0-14.5	0.9-5.5	8.5-11.5	38.8-42.0	49.5-56.8	10,850-12,100
Coal V	11.2-16.1	1.0-7.3	8.5-14.4	39.6-41.7	42.6-49.3	11,000-12,300
Coal VI	11.2-13.5	1.4-6.0	8.4-11.8	39.0-42.9	43.3-48.6	10,580-11,600
Coal VII	11.6-13.7	0.8-4.5	8.2-11.5	39.0-43.2	43.8-52.2	10,460-11,400
<u>West Kentucky</u>						
No. 6 Seam	9.8-16.0	1.9-3.4	2.8-10.0	35.8-42.7	53.0-54.5	10,970-12,820
No. 9 Seam	4.5-6.2	2.8-4.4	9.0-10.5	39.8-40.5	48.0-50.3	12,100-13,000
No. 11 Seam	8.4-12.7	3.2-4.7	0.1-9.0	42.0-44.6	48.4-51.1	11,300-13,000
No. 12 Seam	4.5-13.4	1.1-3.8	7.0-13.4	38.3-40.2	41.2-52.3	10,660-13,100
No. 14 Seam	7.0-11.0	2.0-4.7	7.5-11.0	38.8-42.0	49.0-52.4	11,860-13,000

Figure 5-12 Summary of coal quality statistical data for selected seams in the MWCF
(From Paul Weir and Company, 1965) Data from published and private sources.

Name of Seam	Percent Dry Basis							
	Total Sulfur	Organic	Sulfate	Pyritic				
Colchester No. 2	1.60	5.20	0.70	2.90	0.05	0.09	0.85	4.30
Rock Island No. 1	4.80	6.50	1.50	2.00	0.01	0.02	2.80	4.50
Danville No. 7	3.20	4.70	1.30	2.00	0.01	0.10	1.30	2.70
Illinois No. 5 (Western Ill.)	2.70	4.00	1.60	2.10	0.02	0.08	1.10	2.20
Illinois No. 5 (Springfield)	3.30	4.90	0.90	2.40	0.02	0.05	1.80	2.70
Illinois No. 5 (Southwestern)	3.10	4.50	0.58	1.70	0.01	0.06	1.40	3.90
Illinois No. 6 (Northern Ill.)	3.50	5.40	1.40	1.90	0.01	0.02	1.60	3.50
Illinois No. 6 (Western Ill.)	3.50	6.40	1.60	2.10	0.01	0.02	1.40	3.00
Illinois No. 6 (South & Southwestern)	3.70	5.00	1.20	2.70	0.01	0.02	1.20	3.78
*Note: There are low sulfur areas of No. 6 coal in Franklin-Jefferson and Williamson Counties that run 1.0-1.6 percent total sulfur.								
Coal III	0.90-	7.60	0.62	2.30	0.01	0.10	0.28	5.60
Coal IV	0.90	5.50	0.77	1.30	0.01	0.05	0.22	4.50
Coal V	1.00	7.30	0.64	1.70	0.02	0.04	0.34	5.60
Coal VI	1.40	6.00	0.90	1.66	0.03	0.08	0.47	4.26
Coal VII	0.80	4.50	0.58	1.20	0.02	0.05	0.20	3.25
No. 6 Seam	1.90	3.40	0.66	1.02	0.03	0.10	1.20	2.28
No. 9 Seam	2.80	4.40	1.45	1.84	0.00	0.09	1.35	2.63
No. 11 Seam	3.20	4.70	1.71	2.50	0.05	0.10	1.44	2.25
No. 12 Seam	1.10	3.80	0.73	1.10	0.01	0.02	0.80	2.68
No. 14 Seam	2.00	4.70	0.90	1.14	0.03	0.07	1.07	3.50

Figure 5-13 Distribution of forms of sulfur in major high sulfur coal seams in the MWCF.
(From Paul Weir and Company, 1965) Data from published and private sources.
Other areas in St. Clair and adjacent counties, and Saline County have been reported by Gluskoter and Simon (1968)

TOTAL RESERVES Millions of Short Tons	
ILLINOIS	193,700
INDIANA	50,700
WEST KENTUCKY	16,900
TOTAL, M W C F	261,300

Figure 5-14 Total Available Reserves Summary. (Millions of Short Tons)
This table should be used independently only after careful
reference to study constraints.

<u>State</u>	<u>Bituminous Coal</u>	<u>Estimated additional reserves in unmapped and unexplored areas</u>	<u>Estimated total remaining reserves in the ground, 0-3,000 ft. overburden</u>
Illinois	139,756	100,000	239,756
Indiana	34,779	22,000	56,779
Kentucky	65,958	52,000	117,958
TOTAL	240,493	174,000	414,493

Figure 5-15 Total estimated coal resources of the United States, January 1, 1967, from Averitt, 1968. Figures (in millions of short tons) are for resources in the ground, about half of which may be considered recoverable.

Figure 5-16 Summary of Coal Quality by Seam and County. Table should be used independently only after careful reference to study constraints.

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE	DATA
ILL	1	CASS	015-017						COUNTY	
ILL	1	CHRISTIAN		2.6-2.8	10	115-117			COUNTY	
ILL	1	HENRY		4.8-5.7	10	106-123	2100		COUNTY	
ILL	1	JACKSON		1.1-1.3	07		1990		COUNTY	
ILL	1	KNOX	035-060	3.4-5.3	08	111-123	2070		COUNTY	
ILL	1	MERCER	039-041	4.4-5.3	11	108-127	2100		COUNTY	
ILL	1	ROCK ISLAND		4.8-5.8	09	106-112			COUNTY	
ILL	1	SHELBY	032-034						COUNTY	
ILL	1	WARREN		5.5-6.3	09	112-130			COUNTY	
ILL	2	ADAMS	016-027	4.6-4.8	08	132-134			COUNTY	
ILL	2	BROWN	023-025	5.3-5.5	10	130-132			COUNTY	
ILL	2	BUREAU		2.6-4.3	08	108-112	2010		COUNTY	
ILL	2	CALHOUN	024-030	7.7-7.9	13	143-145			COUNTY	
ILL	2	CASS	030-042						COUNTY	
ILL	2	CHRISTIAN		3.7-3.9	08	115-117			COUNTY	
ILL	2	FULTON	020-030	3.1-3.6	06	116-117	2060	3.5	COUNTY	
ILL	2	GALLATIN	017-019						COUNTY	
ILL	2	GREENE	023-025	4.9-5.1	10	110-111			COUNTY	
ILL	2	GRUNDY	028-039	2.5-3.8	07	108-118	1970		COUNTY	
ILL	2	HANCOCK	030-036	4.2-4.6	08	112-134	2600	3.5	COUNTY	
ILL	2	HARDIN	015-017						COUNTY	
ILL	2	HENDERSON	023-025						COUNTY	
ILL	2	HENRY	031-033	3.5-5.4	11	106-119	1940		COUNTY	
ILL	2	JACKSON	018-048	3.5-4.7	10	121-127	2100		COUNTY	
ILL	2	JERSEY	029-031						COUNTY	
ILL	2	JOHNSON	015-017						COUNTY	
ILL	2	KANKAKEE	035-037	2.7-3.2	07	112-135	2120	3.5	COUNTY	
ILL	2	KNOX	024-030	1.8-2.7	11	080-104		1.0	COUNTY	
ILL	2	LASALLE	035-042	3.8-8.4	11	103-126	2020		COUNTY	
ILL	2	MACOUPIN	029-031						COUNTY	
ILL	2	MADISON	029-031						COUNTY	
ILL	2	MARSHALL	029-031	2.8-3.5	08	113-123			COUNTY	
ILL	2	MASON	033-035						COUNTY	
ILL	2	MC DONOUGH	022-030	2.9-4.6	10	108-117		3.0	COUNTY	
ILL	2	MC LEAN		3.1-3.4	10	114-128	2000		COUNTY	
ILL	2	MERCER	017-019						COUNTY	
ILL	2	MONTGOMERY	034-055						COUNTY	
ILL	2	MORGAN	028-048						COUNTY	
ILL	2	PEORIA	029-031	3.3-4.4	08	116-119	2020	3.0	COUNTY	
ILL	2	PERRY	023-025						COUNTY	
ILL	2	PIKE	018-020						COUNTY	
ILL	2	POPE	015-017						COUNTY	
ILL	2	PUTNAM				121-123			COUNTY	
ILL	2	SALINE	015-017						COUNTY	
ILL	2	SANGAMON	027-029						COUNTY	
ILL	2	SCHUYLER	018-036	4.5-5.1	09	117-130			COUNTY	
ILL	2	SCOTT	028-035						COUNTY	
ILL	2	ST CLAIR	023-025						COUNTY	

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
ILL	2	STARK	029-031						COUNTY
ILL	2	TAZEWELL	029-031						COUNTY
ILL	2	WABASH	020-023						COUNTY
ILL	2	WARREN	024-030						COUNTY
ILL	2	WILL	037-039	1.6-3.4	06	113-120	2050	3.0	COUNTY
ILL	2	WILLIAMSON	015-017	4.4-4.8	14	113-117			COUNTY
ILL	2	WOODFORD	023-025	1.5-2.2	06	114-124	2140		COUNTY
ILL	4	CASS	015-017						COUNTY
ILL	4	DOUGLAS	011-013						COUNTY
ILL	4	GREENE	029-031	3.9-4.2	10	108-122			COUNTY
ILL	4	GRUNDY		3.9-4.1	10	125-127			COUNTY
ILL	4	JACKSON	000-018						COUNTY
ILL	4	JASPER	035-037						COUNTY
ILL	4	JERSEY	015-017						COUNTY
ILL	4	KANKAKEE							COUNTY
ILL	4	KNOX		3.8-4.0	10	127-129			COUNTY
ILL	4	MACOUPIN	015-017	4.3-4.5	10	112-123			COUNTY
ILL	4	MADISON	015-017						COUNTY
ILL	4	MORGAN	015-017						COUNTY
ILL	4	PERRY	023-025						COUNTY
ILL	4	SALINE	023-025	4.1-4.3					COUNTY
ILL	4	SCOTT	015-017						COUNTY
ILL	4	WABASH	011-013						COUNTY
ILL	4	WILLIAMSON	024-046	2.1-4.2					COUNTY
ILL	5	ADAMS	021-023						COUNTY
ILL	5	BROWN	018-024						COUNTY
ILL	5	CLAY							COUNTY
ILL	5	CLINTON	028-042						COUNTY
ILL	5	CRAWFORD	036-042						COUNTY
ILL	5	DOUGLAS	011-013						COUNTY
ILL	5	EDGAR		3.6-3.8	09	121-122	1990		COUNTY
ILL	5	EDWARDS							COUNTY
ILL	5	FRANKLIN	042-062	1.0-6.5					COUNTY
ILL	5	FULTON	048-060	2.7-4.5	13	104-109	2010	4.0	COUNTY
ILL	5	GALLATIN	036-072	2.2-4.7	12	127-135	2130		COUNTY
ILL	5	HAMILTON	048-078						COUNTY
ILL	5	JACKSON	047-049	1.0-4.4	14	107-127			COUNTY
ILL	5	JASPER	041-043						COUNTY
ILL	5	JEFFERSON	042-070						COUNTY
ILL	5	LAWRENCE	036-042						COUNTY
ILL	5	LIVINGSTON		2.7-4.0	14				COUNTY
ILL	5	LOGAN		3.1-4.6	13	102-108	1930		COUNTY
ILL	5	MACON		3.1-4.1	11	106-111	1980		COUNTY
ILL	5	MARION	023-025						COUNTY
ILL	5	MCLEAN	041-043	3.7-4.3	14	106-110			COUNTY
ILL	5	MENARD		3.2-3.8	11	107-122	1990		COUNTY
ILL	5	MONROE	000-024						COUNTY
ILL	5	MONTGOMERY	035-042						COUNTY
ILL	5	PEORIA	050-052	2.8-3.7	13	104-107	2020		COUNTY
ILL	5	PERRY	000-018	2.6-3.2					COUNTY

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	AS4	BTU	AST	FSI	TYPE DATA
ILL	5	RANDOLPH	048-072	4.0-5.0	11	114-125	2120	3.0	COUNTY
ILL	5	SALINE	048-078	1.9-3.0	08	123-132	2080	5.0	COUNTY
ILL	5	SANGAMON	053-055	3.9-4.5	13	101-107	1970	4.5	COUNTY
ILL	5	SCHUYLER	058-061	2.7-5.2	13	108-110	2100	4.5	COUNTY
ILL	5	SHELBY	028-054	3.6-4.3	11	109-126			COUNTY
ILL	5	ST. CLAIR	028-042						COUNTY
ILL	5	STARK	015-017						COUNTY
ILL	5	TAZEWELL		3.2-3.6	10	107-120	2010		COUNTY
ILL	5	VFRMILTON		1.8-2.5	11	121-123	2180		COUNTY
ILL	5	WABASH	036-050						COUNTY
ILL	5	WASHINGTON							COUNTY
ILL	5	WAYNE	042-052						COUNTY
ILL	5	WHITE	036-048						COUNTY
ILL	5	WILLIAMSON	042-060	2.3-4.0	14	118-123	2090	5.5	COUNTY
ILL	6	BOND	066-096	3.7-4.4	12	107-109	2020		COUNTY
ILL	6	BUREAU	052-054	3.5-3.7	10	101-103	1900	4.0	COUNTY
ILL	6	CHRISTIAN	061-108	3.5-5.5	11	107-123	2020	4.5	COUNTY
ILL	6	CLAY							COUNTY
ILL	6	CLINTON	072-096	3.8-4.2	12	107-111	2040	3.0	COUNTY
ILL	6	COLES	017-019						COUNTY
ILL	6	CRAWFORD	030-040						COUNTY
ILL	6	CUMBERLAND	015-017						COUNTY
ILL	6	DOUGLAS	070-086	2.2-2.6	08	115-118	2115	3.5	COUNTY
ILL	6	EDGAR		3.4-3.6	11	112-113	1990		COUNTY
ILL	6	EDWARDS	042-046	2.2-2.4	09	123-125			COUNTY
ILL	6	FAYETTE	076-082	5.2-5.4					COUNTY
ILL	6	FRANKLIN	072-124	0.8-2.6	12	118-122	2450	4.0	COUNTY
ILL	6	FULTON	048-054	2.4-3.8	08	110-119	2180	4.5	COUNTY
ILL	6	GALLATIN	040-049	3.2-4.9	11	106-132			COUNTY
ILL	6	GREENE	027-029						COUNTY
ILL	6	GRUNDY	085-089	3.8-4.5	12	106-123	2066		COUNTY
ILL	6	HENRY	036-040	2.8-4.8	09	097-107	2100	4.5	COUNTY
ILL	6	JACKSON	042-072	1.2-3.7	11	109-123	2190	4.0	COUNTY
ILL	6	JASPER	041-043						COUNTY
ILL	6	JEFFERSON	028-108	1.0-3.8	09	112-133	2300	5.0	COUNTY
ILL	6	KNOX	036-048	2.9-3.7	10	101-116	2050	2.5	COUNTY
ILL	6	LASALLE		3.4-4.2	11	104-112	2110		COUNTY
ILL	6	LAWRENCE	030-040						COUNTY
ILL	6	LIVINGSTON		3.6-4.3	14	108-110	2030		COUNTY
ILL	6	MACON		4.4-4.6	11	117-119			COUNTY
ILL	6	MACOUPIN	072-096	2.4-5.4	11	105-116	2020	4.0	COUNTY
ILL	6	MADISON	051-096	2.0-5.0	11	107-116	2080	4.0	COUNTY
ILL	6	MARION	072-096	3.8-4.6	13	110-128	2040	5.0	COUNTY
ILL	6	MARSHALL		4.3-4.5	18	090-110			COUNTY
ILL	6	MONTGOMERY	072-096	3.5-5.5	11	100-112	2000	3.5	COUNTY
ILL	6	MORGAN	028-048						COUNTY
ILL	6	MOULTRIE	066-106	4.0-4.3	12	118-137			COUNTY
ILL	6	PEORIA	036-053	2.4-4.4	08	103-119	2200	4.0	COUNTY
ILL	6	PERRY	048-096	0.9-4.5	11	109-118	2200	1.0	COUNTY
ILL	6	PUTNAM				122-124			COUNTY

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	RTU	AST	FSI	TYPE DATA
ILL	6	RANDOLPH	065-076	3.1-4.3	11	108-113	2100	3.5	COUNTY
ILL	6	ROCK ISLAND	048-134						COUNTY
ILL	6	SALINE	054-096	1.4-4.6	14	119-123			COUNTY
ILL	6	SANGAMON	072-096	4.1-5.5	11	107-120			COUNTY
ILL	6	SCHUYLER		4.2-4.4	13	110-112			COUNTY
ILL	6	SHELBY	061-076	4.2-4.4	14				COUNTY
ILL	6	ST CLAIR	072-096	3.0-4.6	12	104-112	2050	4.0	COUNTY
ILL	6	STARK	048-054	2.4-4.9	23	103-111	2050	3.5	COUNTY
ILL	6	TAZEWELL	029-031	3.6-3.8	12	102-104			COUNTY
ILL	6	VERMILION	049-084	2.3-3.3	29	108-114	2170		COUNTY
ILL	6	WABASH	043-048	2.2-2.4	29	123-125			COUNTY
ILL	6	WASHINGTON	074-090	2.6-4.6	12	109-112	2040	4.5	COUNTY
ILL	6	WAYNE	046-064	2.3-3.8	10	112-124			COUNTY
ILL	6	WHITE		2.9-3.1	29	119-133			COUNTY
ILL	6	WILLIAMSON	048-148	1.3-4.1	14	114-125	2300	5.5	COUNTY
ILL	7	BUREAU	029-031	3.2-3.8	15	097-115	2100		COUNTY
ILL	7	COLES	007-084						COUNTY
ILL	7	CRAWFORD	030-040						COUNTY
ILL	7	CUMBERLAND	007-084						COUNTY
ILL	7	DOUGLAS	007-084	1.8-2.6	05		2060	5.0	COUNTY
ILL	7	FULTON	017-019						COUNTY
ILL	7	GALLATIN	018-030						COUNTY
ILL	7	HARDIN	018-030						COUNTY
ILL	7	HENRY	029-031						COUNTY
ILL	7	JACKSON	023-025						COUNTY
ILL	7	JASPER	029-031						COUNTY
ILL	7	JOHNSON	018-030						COUNTY
ILL	7	KANKAKEE	036-042	2.7-2.9	28	111-113	2070	2.5	COUNTY
ILL	7	KNOX	017-019						COUNTY
ILL	7	LAWRENCE	030-040						COUNTY
ILL	7	LIVINGSTON		1.7-4.5	15	105-107	2040		COUNTY
ILL	7	MADISON	047-049						COUNTY
ILL	7	MARSHALL	042-048	3.6-4.8	17	100-119			COUNTY
ILL	7	MOULTRIE	042-048						COUNTY
ILL	7	PEORIA	017-019	3.5-3.7	17	101-103			COUNTY
ILL	7	PERRY	015-017						COUNTY
ILL	7	POPE	018-030						COUNTY
ILL	7	RANDOLPH	023-025						COUNTY
ILL	7	SALINE	018-030						COUNTY
ILL	7	SANGAMON							COUNTY
ILL	7	SHELBY	041-043						COUNTY
ILL	7	ST CLAIR	011-013						COUNTY
ILL	7	STARK	029-031						COUNTY
ILL	7	VERMILION	060-072	2.6-3.8	10	108-113	2100	3.5	COUNTY
ILL	7	WILLIAMSON	018-028						COUNTY
ILL	8	MOULTRIE	005-007						COUNTY

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR	CONTENT	ASH	BTU	AST	FSI	TYPE DATA
ILL	8	SANGAMON								COUNTY
ILL	8	SHELBY	005-007							COUNTY
ILL	ABINGDON	KNOX	023-025							COUNTY
ILL	ASSUMPTION	CHRISTIAN			2.5-2.7	10	115-117			COUNTY
ILL	BATTERY ROCK	GALLATIN	019-021							COUNTY
ILL	BRIAR HILL	MARION	000-024							COUNTY
ILL	BRIAR HILL	POPE	015-017							COUNTY
ILL	BRIAR HILL	SALINE	015-017							COUNTY
ILL	BRIAR HILL	WABASH								COUNTY
ILL	BRIAR HILL	WASHINGTON								COUNTY
ILL	BRIAR HILL	WILLIAMSON	015-017							COUNTY
ILL	DAVIS	GALLATIN	041-043		5.3-5.5					COUNTY
ILL	DAVIS	SALINE	042-048		3.2-5.0	11	126-127	2160	8.0	COUNTY
ILL	DAVIS	WABASH	039-041							COUNTY
ILL	DAVIS	WILLIAMSON	036-038		3.1-5.0	11		2410		COUNTY
ILL	DEKOVEN	GALLATIN	037-039		4.1-4.3					COUNTY
ILL	DEKOVEN	SALINE	036-042		1.9-5.9	11	111-121			COUNTY
ILL	DEKOVEN	WILLIAMSON	037-039		3.1-3.7	29	120-128	2030	5.0	COUNTY
ILL	FRIENDSVILLE	WABASH	018-060		1.7-1.9	11	106-108			COUNTY
ILL	INDIANA III	EDWARDS								COUNTY
ILL	JACKSONVILLE	MORGAN	041-043							COUNTY
ILL	JAMESTOWN	EDWARDS								COUNTY
ILL	JAMESTOWN	GALLATIN	004-006							COUNTY
ILL	JAMESTOWN	WABASH	023-025							COUNTY
ILL	JAMESTOWN	WAYNE								COUNTY
ILL	LITCHFIELD	SANGAMON	053-055							COUNTY
ILL	MAKANDA	RANDOLPH	001-018							COUNTY
ILL	MAKANDA	ST CLAIR	000-018							COUNTY
ILL	MURPHYSBORO	JACKSON	024-035		1.3-4.3	08	124-137	2200		COUNTY
ILL	MURPHYSBORO	PERRY	017-019							COUNTY
ILL	MURPHYSBORO	WILLIAMSON	042-072		4.4-4.8	09	125-128			COUNTY
ILL	NEW BURNSIDE	JOHNSON	036-042		2.1-2.3	06	128-130			COUNTY
ILL	O NAN	GALLATIN	015-017							COUNTY
ILL	O NAN	HARDIN	015-017							COUNTY
ILL	O NAN	JOHNSON	015-017							COUNTY
ILL	O NAN	POPE	015-019							COUNTY
ILL	O NAN	SALINE	015-017							COUNTY
ILL	O NAN	WILLIAMSON	015-017							COUNTY
ILL	OPDYKE	JEFFERSON								COUNTY
ILL	OPDYKE	MARION	011-013							COUNTY
ILL	REYNOLDSBURG	GALLATIN	019-021							COUNTY
ILL	REYNOLDSBURG	JOHNSON	033-035							COUNTY
ILL	REYNOLDSBURG	POPE	041-043							COUNTY

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SJLFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
ILL	SEAHORNE	PERRY	047-049						COUNTY
ILL	SHAWNEETOWN	GALLATIN	017-019						COUNTY
ILL	SHAWNEETOWN	POPE	015-017						COUNTY
ILL	SHAWNEETOWN	SALINE	015-017						COUNTY
ILL	SHAWNEETOWN	WILLIAMSON	015-017						COUNTY
ILL	TARTER	GALLATIN	041-043	4.5-4.7	10	130-132	2070		COUNTY
ILL	TROWBRIDGE	SHELBY	027-029	2.4-2.6	21	091-093			COUNTY
ILL	WISE RIDGE	GALLATIN	017-019						COUNTY
ILL	WISE RIDGE	HARDIN	015-017						COUNTY
ILL	WISE RIDGE	JOHNSON	015-017						COUNTY
ILL	WISE RIDGE	POPE	015-017						COUNTY
ILL	WISE RIDGE	SALINE	015-017						COUNTY
ILL	WISE RIDGE	WILLIAMSON	015-017						COUNTY

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
IND	BLUE CREEK	DAVIESS	024-036	C.6-6.3	38	107-120			COUNTY
IND	BLUE CREEK	MARTIN	036-054	C.8-1.0	34	115-119	2410		COUNTY
IND	BRAZIL-U	DUBOIS	012-036						COUNTY
IND	BRAZIL-U	SPENCER	016-018	1.2-7.4	17	099-113	2450		COUNTY
IND	CANNELTON	PERRY	000-024	3.0-3.2	33	119-121			COUNTY
IND	COAL I	DUBOIS	024-048	2.0-2.1	10				COUNTY
IND	COAL I	GREENE	030-060	2.0-2.1	39				COUNTY
IND	COAL I	MARTIN	009-024	4.6-4.8	38	117-119			COUNTY
IND	COAL I	ORANGE	000-032						COUNTY
IND	COAL I	PERRY	024-036	C.9-2.9	38	083-114			COUNTY
IND	COAL I	PIKE	018-030	3.0-5.3					COUNTY
IND	COAL I	SPENCER	048-053						COUNTY
IND	COAL I	VIGO	000-048						COUNTY
IND	COAL IA	DUBOIS	005-048						COUNTY
IND	COAL IA	MARTIN	014-048						COUNTY
IND	COAL IA	ORANGE	000-036	0.9-1.1	35	120-121	2650		COUNTY
IND	COAL II	OWEN	000-042						COUNTY
IND	COAL II	PARKE	000-009	5.5-6.1	28	086-088	2140		COUNTY
IND	COAL II	VIGO	000-037						COUNTY
IND	COAL III	CLAY	024-096	3.8-6.3	12	100-116	2100	3.5	COUNTY
IND	COAL III	DAVIESS	024-048						COUNTY
IND	COAL III	DUBOIS	026-036	3.6-3.8	09	119-121	2300		COUNTY
IND	COAL III	FOUNTAIN	024-048	2.1-3.7	16	099-107	2280		COUNTY
IND	COAL III	GIBSON	036-060	1.9-5.4	18	100-117	2400		COUNTY
IND	COAL III	GREENE	024-072	3.3-4.8	14	108-119	2125		COUNTY
IND	COAL III	KNOX	024-060						COUNTY
IND	COAL III	OWEN	038-050						COUNTY
IND	COAL III	PARKE	018-040	2.5-5.0	14	100-110	2100		COUNTY
IND	COAL III	PIKE	000-048						COUNTY
IND	COAL III	SPENCER	018-040	3.7-3.9	37	117-119	1930		COUNTY
IND	COAL III	SULLIVAN	024-084	0.6-3.8	07	116-118	2350	5.5	COUNTY
IND	COAL III	VANDERBURG	000-040						COUNTY
IND	COAL III	VFRMILION	023-072	3.3-6.2	10	090-120	2120		COUNTY
IND	COAL III	VIGO	024-078	1.8-5.0	10	105-121	2100	4.0	COUNTY
IND	COAL III	WARRICK	024-072	2.1-4.4	18	097-116	2185		COUNTY
IND	COAL IIIA	DAVIESS	024-048						COUNTY
IND	COAL IIIA	GREENE	024-072(?)	4.3-4.5	11	113-115	2140		COUNTY
IND	COAL IIIA	PARKE	012-024	1.3-3.9	11	070-120	2100		COUNTY
IND	COAL IIIA	PIKE	000-012						COUNTY
IND	COAL IIIA	POSEY	000-014	0.6-0.8	14	111-113			COUNTY
IND	COAL IIIA	VANDERBURG	012-016						COUNTY
IND	COAL IIIA	VIGO	024-048	3.1-6.8	14	102-106	2060		COUNTY
IND	COAL IIIA	WARREN	000-030	2.2-2.3	33	108-109	2130		COUNTY
IND	COAL IIIA	WARRICK	015-018	6.1-6.3	18	110-111	2050		COUNTY
IND	COAL IV	CLAY	026-056	1.5-3.2	10	112-117	1322		COUNTY
IND	COAL IV	DAVIESS	024-036	2.0-2.2					COUNTY
IND	COAL IV	GREENE	024-060	1.0-2.6	11	112-136	2450		COUNTY
IND	COAL IV	KNOX	024-060	1.0-2.4	38	119-130	2300		COUNTY
IND	COAL IV	MARTIN		2.0-2.1	35				COUNTY
IND	COAL IV	OWEN		2.0-2.1	06				COUNTY

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STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE	DATA
IND	COAL IV	PARKE	000-036	2.0-2.1	06				COUNTY	
IND	COAL IV	PERRY		2.0-2.1	06				COUNTY	
IND	COAL IV	PIKE	012-048	3.7-4.3	10	115-120	2250	4.5	COUNTY	
IND	COAL IV	POSEY		2.0-2.1	06				COUNTY	
IND	COAL IV	PUTNAM		2.0-2.1	06				COUNTY	
IND	COAL IV	SPENCER	018-024	2.0-4.3	09	112-114			COUNTY	
IND	COAL IV	SULLIVAN	024-050	1.0-2.7	09	114-122	2490	4.5	COUNTY	
IND	COAL IV	VANDERBURG	012-016	2.0-2.1	06				COUNTY	
IND	COAL IV	VERMILION	048-070	0.8-1.8	10	113-115	2450		COUNTY	
IND	COAL IV	VIGO	024-050	0.7-3.0	09	109-118	2488	5.5	COUNTY	
IND	COAL IV	WARRICK	024-036	2.0-4.5	13	114-115	2030		COUNTY	
IND	COAL IVA	DAVIESS	012-018	1.2-1.4	20	070-071	2400		COUNTY	
IND	COAL IVA	GREENE	012-018						COUNTY	
IND	COAL IVA	KNOX	012-018						COUNTY	
IND	COAL IVA	PIKE	000-036						COUNTY	
IND	COAL IVA	POSEY	000-026	0.7-0.9	16	105-107			COUNTY	
IND	COAL IVA	SULLIVAN	018-048	4.8-5.0	33	094-096	2010		COUNTY	
IND	COAL IVA	VERMILION	010-014						COUNTY	
IND	COAL IVA	VIGO	024-072						COUNTY	
IND	COAL V	CLAY	082-085	3.4-3.5	10	113-116	2000		COUNTY	
IND	COAL V	DAVIESS	030-096						COUNTY	
IND	COAL V	GIBSON	024-084	2.0-5.5	10	115-130	2125		COUNTY	
IND	COAL V	GREENE	024-072	2.8-5.0	12	110-119	2250	4.0	COUNTY	
IND	COAL V	KNOX	024-084	1.1-5.1	10	102-121	2150	5.0	COUNTY	
IND	COAL V	PARKE	000-060						COUNTY	
IND	COAL V	PIKE	036-084	1.0-5.5	10	114-116	2195	4.5	COUNTY	
IND	COAL V	POSEY	048-084						COUNTY	
IND	COAL V	SPENCER	000-036						COUNTY	
IND	COAL V	SULLIVAN	036-084	0.8-5.2	10	109-121	2175	4.5	COUNTY	
IND	COAL V	VANDERBURG	048-084	3.5-5.3	13	110-114	2000		COUNTY	
IND	COAL V	VERMILION	036-060	2.8-5.0	12	106-119	1988		COUNTY	
IND	COAL V	VIGO	024-084	2.9-4.9	12	101-119	2175	4.0	COUNTY	
IND	COAL V	WARRICK	036-084	3.0-5.0	11	109-118	2115	4.5	COUNTY	
IND	COAL VA	KNOX	018-024						COUNTY	
IND	COAL VA	SULLIVAN	000-036						COUNTY	
IND	COAL VA	VERMILION	018-048						COUNTY	
IND	COAL VA	VIGO	009-028						COUNTY	
IND	COAL VB	DAVIESS	024-048						COUNTY	
IND	COAL VB	GREENE	018-024	4.7-4.9		100-110			COUNTY	
IND	COAL VB	PIKE	012-015	2.6-6.6	20	080-109	2000		COUNTY	
IND	COAL VB	POSEY	000-020	0.8-1.4	18	103-110			COUNTY	
IND	COAL VB	SULLIVAN	024-036	3.4-3.6		109-110			COUNTY	
IND	COAL VB	VERMILION	007-041	7.0-8.0					COUNTY	
IND	COAL VB	VIGO	012-048	2.5-3.0	16	100-102	2190		COUNTY	
IND	COAL VB	WARRICK	000-004	4.5-4.7	19	106-108	2050		COUNTY	
IND	COAL VI	DAVIESS	030-050						COUNTY	
IND	COAL VI	GIBSON	024-048	2.0-3.2	10	113-115	2120		COUNTY	
IND	COAL VI	GREENE	024-084	2.4-2.8	10	110-115	2100		COUNTY	
IND	COAL VI	KNOX	024-084	2.3-5.1	11	104-116	2020	4.5	COUNTY	
IND	COAL VI	PIKE	014-054	1.8-2.9	11	106-114	2450	4.5	COUNTY	

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SJLFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
IND	COAL VI	POSEY	036-060	0.7-0.8	24	077-120			COUNTY
IND	COAL VI	SULLIVAN	024-084	1.1-3.9	10	106-118	2200	3.5	COUNTY
IND	COAL VI	VERMILION	066-072	2.6-3.0	10	110-118	2045	4.5	COUNTY
IND	COAL VI	VIGO	032-082	2.6-4.4	12	111-112	2025	4.0	COUNTY
IND	COAL VI	WARRICK	024-082	2.0-4.0	10	103-120	2250	4.0	COUNTY
IND	COAL VII	DAVISS	023-025						COUNTY
IND	COAL VII	GIBSON	024-060	2.8-3.0					COUNTY
IND	COAL VII	GREENE	024-072	1.0-2.2	10	108-111	2565	4.0	COUNTY
IND	COAL VII	KNOX	024-072	1.3-4.5	20	105-117	2500		COUNTY
IND	COAL VII	PIKE	024-072	1.1-2.0	10	103-114	2220		COUNTY
IND	COAL VII	POSEY	020-072	0.8-0.9	10	115-117			COUNTY
IND	COAL VII	SULLIVAN	024-072	0.5-3.5	11	102-116	2460	4.0	COUNTY
IND	COAL VII	VANDERBURG	024-072						COUNTY
IND	COAL VII	VERMILION	024-072	2.5-3.5	10	103-118	2045		COUNTY
IND	COAL VII	VIGO	024-072	1.1-2.0	10	106-114	2300	3.0	COUNTY
IND	COAL VII	WARRICK	030-090	0.9-5.0	11	082-120	2350		COUNTY
IND	COAL VIIA	GIBSON	011-012						COUNTY
IND	COHN	SULLIVAN	012-016						COUNTY
IND	DALE	DUBOIS	019-020	2.9-3.0	06	126-132	2085		COUNTY
IND	DITNEY	GIBSON	023-025						COUNTY
IND	DITNEY	KNOX	004-018	2.5-6.3	28	083-105	2500		COUNTY
IND	DITNEY	POSEY	014-017	0.7-2.9	13	105-112			COUNTY
IND	DITNEY	SULLIVAN	000-004						COUNTY
IND	DITNEY	VANDERBURG	012-016						COUNTY
IND	DITNEY	WARRICK	000-011						COUNTY
IND	FAIRBANKS	GIBSON	011-013						COUNTY
IND	FAIRBANKS	POSEY	000-012						COUNTY
IND	FAIRBANKS	SULLIVAN	018-048	0.7-2.8	27	067-100	2350		COUNTY
IND	FRIENDSVILLE	GIBSON	011-013						COUNTY
IND	FRIENDSVILLE	POSEY	000-012						COUNTY
IND	FRIENDSVILLE	WABASH	036-040	1.7-1.9	11	106-107			COUNTY
IND	HAZELTON BRIDGE	GIBSON	000-015						COUNTY
IND	HAZELTON BRIDGE	KNOX	000-015						COUNTY
IND	HAZELTON BRIDGE	POSEY	000-021	0.7-0.9	29	082-084			COUNTY
IND	LOWER BLOCK	CLAY	030-066	1.9-3.0	16	105-116	2600		COUNTY
IND	LOWER BLOCK	DUBOIS	006-056	1.0-2.0	09	117-119	2600		COUNTY
IND	LOWER BLOCK	GREENE	024-036	0.7-0.9	11	095-116			COUNTY
IND	LOWER BLOCK	MARTIN	000-048						COUNTY
IND	LOWER BLOCK	OWEN	018-060	0.7-2.2	08	097-134	2340		COUNTY
IND	LOWER BLOCK	PARKE	012-048	1.0-5.0	15	063-124	2200		COUNTY
IND	LOWER BLOCK	SPENCER	027-029	0.6-0.8	13	105-107	2500		COUNTY
IND	LOWER BLOCK	SULLIVAN	000-036						COUNTY
IND	LOWER BLOCK	VERMILION	000-012						COUNTY
IND	LOWER BLOCK	VIGO	000-044						COUNTY
IND	MANSFIELD-U	DUBOIS	015-060	0.5-3.9	14	052-112	2550		COUNTY
IND	MANSFIELD-U	GREENE	021-040						COUNTY
IND	MANSFIELD-U	MARTIN	024-048	3.8-4.0	09	115-117	2340		COUNTY
IND	MANSFIELD-U	MONROE	018-020	1.2-1.4					COUNTY
IND	MANSFIELD-U	SPENCER	025-048	2.0-2.1	06	118-120	2450		COUNTY
IND	MANSFIELD-U	WARRICK	004-015	0.9-5.8	16	113-125	2530		COUNTY

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STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
IND	MARIAH HILL	DAVIESS	024-040	1.3-6.8	13	108-118	1990		COUNTY
IND	MARIAH HILL	DUBOIS	028-072		12	114-115			COUNTY
IND	MARIAH HILL	GREENE	021-040						COUNTY
IND	MARIAH HILL	MARTIN	024-048						COUNTY
IND	MARIAH HILL	SPENCER	016-042	0.7-4.0	11	099-114			COUNTY
IND	MC CLEARYS BLUFF	GIBSON	000-007						COUNTY
IND	MC CLEARYS BLUFF	POSEY	000-007						COUNTY
IND	MINSHALL	DAVIESS	024-048		13	106-108	2140		COUNTY
IND	MINSHALL	DUBOIS	024-048	6.3-6.5	11	116-118			COUNTY
IND	MINSHALL	FOUNTAIN	024-054	1.0-4.9	10	106-117	2070		COUNTY
IND	MINSHALL	GIBSON	040-042	3.5-4.4	16	113-117			COUNTY
IND	MINSHALL	GREENE	020-024	1.0-2.5	06	114-122			COUNTY
IND	MINSHALL	OWEN	000-014						COUNTY
IND	MINSHALL	PARKE	012-054	1.1-3.4	14	055-126	2335		COUNTY
IND	MINSHALL	SPENCER	024-048	1.1-3.5	08	100-118	2250		COUNTY
IND	MINSHALL	SULLIVAN	000-036						COUNTY
IND	MINSHALL	VERMILION	000-012						COUNTY
IND	MINSHALL	VIGO	036-060						COUNTY
IND	MINSHALL	WARREN	030-048	2.0-2.1	11	074-075	2740		COUNTY
IND	MINSHALL	WARRICK	000-008	6.2-6.4	15	111-113	1980		COUNTY
IND	PARKER	POSEY	006-018	0.5-0.7	36	075-077			COUNTY
IND	PARKER	VANDERBURG	006-018						COUNTY
IND	SILVER WOOD	WARRICK	009-020	2.5-9.3	15	103-124	2150		COUNTY
IND	STAUNTON-U	DAVIESS	024-044						COUNTY
IND	STAUNTON-U	DUBOIS	024-048						COUNTY
IND	STAUNTON-U	FOUNTAIN	024-048	2.1-6.7	14	110-113	2250		COUNTY
IND	STAUNTON-U	GIBSON	007-016	3.3-3.5	14	118-120	1150		COUNTY
IND	STAUNTON-U	GREENE	015-017	1.3-1.5	07	115-117			COUNTY
IND	STAUNTON-U	PARKE	012-048	1.9-4.8	14	090-120	2040		COUNTY
IND	STAUNTON-U	VERMILION	000-012						COUNTY
IND	STAUNTON-U	WARREN	012-036	2.4-2.6	09	112-119	2340		COUNTY
IND	STAUNTON-U	WARRICK	003-004	4.0-7.7	20	101-108	2020	1.0	COUNTY
IND	UPPER 8 BLOCK	CLAY	032-048	0.6-3.2	05	111-118	2500		COUNTY
IND	UPPER 8 BLOCK	DAVIESS	015-066	1.2-2.5	10	104-120	2265		COUNTY
IND	UPPER 8 BLOCK	DUBOIS	026-030	3.1-6.7	13	090-105	2020		COUNTY
IND	UPPER 8 BLOCK	FOUNTAIN	018-048	1.3-1.5	14	092-094			COUNTY
IND	UPPER 8 BLOCK	GREENE	024-050	0.8-1.8	07	114-116	2400		COUNTY
IND	UPPER 8 BLOCK	MARTIN	028-030	4.4-4.6	08	119-120	2030		COUNTY
IND	UPPER 8 BLOCK	OWEN	018-066	0.8-2.5	08	100-114	2400		COUNTY
IND	UPPER 8 BLOCK	PARKE	006-036	1.4-4.1	15	105-119	2150		COUNTY
IND	UPPER 8 BLOCK	SPENCER	018-048	0.6-1.4	09	090-107	2500		COUNTY
IND	UPPER 8 BLOCK	SULLIVAN	000-036						COUNTY
IND	UPPER 8 BLOCK	VERMILION	070-078						COUNTY
IND	UPPER 8 BLOCK	VIGO	044-048						COUNTY

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STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SJLFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
WKY	1B	CRITTENDEN	032-042	2.6-3.4	07	129-137			COUNTY
WKY	1B	HOPKINS				133-135			COUNTY
WKY	1B	UNION	032-049	0.9-3.0	07	112-141	2270		COUNTY
WKY	1B	WEBSTER	027-029						COUNTY
WKY	4	BUTLER	024-048	3.5-3.7	08	122-124			COUNTY
WKY	4	CALDWELL	000-060	2.8-3.0	05	124-126			COUNTY
WKY	4	CHRISTIAN	036-048	0.8-2.7	05	112-127	2030		COUNTY
WKY	4	HOPKINS	024-060	1.2-3.4	05	129-131	2080	5.0	COUNTY
WKY	4	OHIO	000-048						COUNTY
WKY	4	WEBSTER	000-024						COUNTY
WKY	5	CALDWELL	000-024						COUNTY
WKY	5	CHRISTIAN	000-024						COUNTY
WKY	5	HOPKINS	000-024						COUNTY
WKY	5	MUHLENBERG	041-043						COUNTY
WKY	5	OHIO	012-024						COUNTY
WKY	5	UNION	053-055						COUNTY
WKY	5	WEBSTER	000-012						COUNTY
WKY	6	BUTLER		2.8-4.3	11	105-111			COUNTY
WKY	6	CALDWELL	006-048						COUNTY
WKY	6	CHRISTIAN	006-054	1.6-2.4	03	131-140	2100		COUNTY
WKY	6	CRITTENDEN	042-048						COUNTY
WKY	6	DAVIESS	012-024	4.5-5.6	11	109-110			COUNTY
WKY	6	HANCOCK		1.8-3.6	12	112-119	2050	3.5	COUNTY
WKY	6	HENDERSON	047-049						COUNTY
WKY	6	HOPKINS	018-054	1.1-4.9		110-120	2050	4.5	COUNTY
WKY	6	MUHLENBERG	036-054	1.7-4.5	16	109-120	2120	4.0	COUNTY
WKY	6	OHIO	012-024	1.3-3.7	12	109-117			COUNTY
WKY	6	UNION	048-060	2.7-4.1	09	122-132	2170	7.0	COUNTY
WKY	6	WEBSTER	024-048	3.0-4.4	13	110-130	2150		COUNTY
WKY	7	CALDWELL	006-044						COUNTY
WKY	7	CHRISTIAN	018-044						COUNTY
WKY	7	HENDERSON	000-024						COUNTY
WKY	7	HOPKINS	012-036						COUNTY
WKY	7	MUHLENBERG	000-036						COUNTY
WKY	7	UNION	035-037	3.1-4.3	11	124-130			COUNTY
WKY	8	CALDWELL	020-023						COUNTY
WKY	8	CHRISTIAN	021-023						COUNTY
WKY	8	HOPKINS	012-036						COUNTY
WKY	8	MUHLENBERG	012-048						COUNTY
WKY	8	OHIO	021-023						COUNTY
WKY	8	UNION	012-036		07				COUNTY
WKY	8B	CALDWELL	017-019						COUNTY
WKY	8B	CHRISTIAN	000-018						COUNTY
WKY	8B	DAVIESS	000-018						COUNTY
WKY	8B	UNION	006-009						COUNTY
WKY	8B	WEBSTER	000-036						COUNTY
WKY	9	BUTLER	048-060	3.4-3.6	07				COUNTY
WKY	9	CALDWELL	036-072						COUNTY
WKY	9	CHRISTIAN	036-072						COUNTY
WKY	9	CRITTENDEN	052-062						COUNTY

LIST OF COUNTY SUMMARY DATA FROM COUNTY CARDS

STATE	SPAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE DATA
WKY	9	DAVIESS	054-058	2.5-4.0	12	107-109	2400	5.0	COUNTY
WKY	9	HENDERSON	045-072	2.7-5.0	13	110-119	2050		COUNTY
WKY	9	HOPKINS	036-072	3.0-4.5	12	114-135	2150	5.5	COUNTY
WKY	9	MC LEAN	050-058	2.3-2.5	11	111-120	2340		COUNTY
WKY	9	MUHLENBERG	024-060	2.9-4.5	11	110-130	2125	5.0	COUNTY
WKY	9	OHIO	036-060	3.0-4.4	12	106-120	2165	4.5	COUNTY
WKY	9	UNION	048-060	3.1-4.6	12	113-126	2075	5.5	COUNTY
WKY	9	WEBSTER	024-060	2.6-4.3	12	110-122	2125	6.5	COUNTY
WKY	10	CALDWELL	011-013						COUNTY
WKY	10	CHRISTIAN	011-013						COUNTY
WKY	10	CRITTENDEN	010-048						COUNTY
WKY	10	HOPKINS	018-078						COUNTY
WKY	10	MC LEAN	000-006						COUNTY
WKY	10	MUHLENBERG	012-072						COUNTY
WKY	10	UNION		4.0-4.2	11	121-124	1980		COUNTY
WKY	10	WEBSTER	030-056						COUNTY
WKY	11	BUTLER	060-085	2.9-3.1	06				COUNTY
WKY	11	CALDWELL	048-072						COUNTY
WKY	11	CHRISTIAN	048-072						COUNTY
WKY	11	CRITTENDEN	055-072						COUNTY
WKY	11	DAVIESS	024-072	3.3-3.5	08	127-129	2170		COUNTY
WKY	11	HENDERSON	060-072		10	112-114			COUNTY
WKY	11	HOPKINS	024-084	3.1-4.5	08	115-135	2180	4.5	COUNTY
WKY	11	MUHLENBERG	048-084	3.0-4.5	09	108-126	2150	4.0	COUNTY
WKY	11	OHIO	024-072	3.0-4.6	09	111-119	2330	3.0	COUNTY
WKY	11	UNION	024-072	3.4-4.3	10	116-119	2170	6.5	COUNTY
WKY	11	WEBSTER	024-084	2.8-4.0	14	112-128	2090	6.0	COUNTY
WKY	12	CALDWELL	024-048						COUNTY
WKY	12	CHRISTIAN	024-072						COUNTY
WKY	12	CRITTENDEN	071-073						COUNTY
WKY	12	DAVIESS	036-060	5.0-6.0	16	113-115	2314		COUNTY
WKY	12	HENDERSON	036-060	1.8-3.3	10	110-118	2020		COUNTY
WKY	12	HOPKINS	024-054	3.1-3.5	13	109-117	2300	4.5	COUNTY
WKY	12	MC LEAN	012-024						COUNTY
WKY	12	MUHLENBERG	036-060	1.4-3.8	12	109-115	2290	3.5	COUNTY
WKY	12	OHIO	024-060	4.7-5.0	15	110-114	2314		COUNTY
WKY	12	UNION	036-060	1.4-5.8	12	113-127	2260		COUNTY
WKY	12	WEBSTER	036-072	1.6-4.4	09	106-130	2190		COUNTY
WKY	13	CALDWELL	017-019						COUNTY
WKY	13	CHRISTIAN	017-019						COUNTY
WKY	13	DAVIESS		1.0-3.0	07	124-126	2220		COUNTY
WKY	13	HENDERSON		2.0-2.9	10	108-126			COUNTY
WKY	13	HOPKINS	000-050	1.9-2.1	07	124-126	1220		COUNTY
WKY	13	MUHLENBERG	024-048	1.9-3.6	13	109-115	2700	4.0	COUNTY
WKY	13	OHIO	012-060	1.9-2.1	07	124-126	2220		COUNTY
WKY	13	WEBSTER	024-072	1.6-3.3	08	124-129	2220		COUNTY
WKY	14	CALDWELL	019-089						COUNTY
WKY	14	CHRISTIAN	018-048						COUNTY
WKY	14	CRITTENDEN	036-060						COUNTY
WKY	14	HENDERSON	083-085	2.2-2.8	12	105-111			COUNTY

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STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR CONTENT	ASH	BTU	AST	FSI	TYPE	DATA
WKY	14	HOPKINS	024-108	2.9-4.6	10	108-125	2125	3.5	COUNTY	COUNTY
WKY	14	MC LEAN	053-055						COUNTY	COUNTY
WKY	14	MUHLENBERG	060-084	1.7-3.9	39	110-126	2250	4.0	COUNTY	COUNTY
WKY	14	OHIO	062-120	1.6-5.0	39	106-136			COUNTY	COUNTY
WKY	14	UNION	064-066	2.8-2.9	09	124-126	2130	5.5	COUNTY	COUNTY
WKY	14	WEBSTER	024-144	2.1-4.0	10	114-127	2135	5.5	COUNTY	COUNTY
WKY	15	HOPKINS	000-036						COUNTY	COUNTY
WKY	15	MC LEAN	021-023						COUNTY	COUNTY
WKY	15	MUHLENBERG	006-036						COUNTY	COUNTY
WKY	15	WEBSTER	000-018						COUNTY	COUNTY
WKY	15	BUTLER	036-048						COUNTY	COUNTY
WKY	15	WARREN	000-030						COUNTY	COUNTY
WKY	15	BUTLER	018-030						COUNTY	COUNTY
WKY	15	WARREN	000-030						COUNTY	COUNTY
WKY	15	WEBSTER	023-025						COUNTY	COUNTY
WKY	15	MUHLENBERG		3.1-4.9	10	108-113	2040		COUNTY	COUNTY
WKY	15	BRECKINRIDGE	020-048						COUNTY	COUNTY
WKY	15	DAVIESS	000-048						COUNTY	COUNTY
WKY	15	GRAYSON	000-036						COUNTY	COUNTY
WKY	15	HANCOCK	020-048						COUNTY	COUNTY
WKY	15	BUTLER	024-048	1.7-4.3	13	105-127			COUNTY	COUNTY
WKY	15	HOPKINS		4.6-4.8	15	109-111			COUNTY	COUNTY
WKY	15	OHIO		1.2-4.3	34				COUNTY	COUNTY
WKY	15	WARREN		3.3-3.5	07	131-133			COUNTY	COUNTY
WKY	15	BUTLER							COUNTY	COUNTY
WKY	15	GRAYSON							COUNTY	COUNTY
WKY	15	WARREN							COUNTY	COUNTY
WKY	15	DAVIESS							COUNTY	COUNTY
WKY	15	EDMONDSON		3.3-3.5	38				COUNTY	COUNTY
WKY	15	HANCOCK	024-048	2.3-3.4	07	120-122			COUNTY	COUNTY
WKY	15	DAVIESS	036-042	2.3-3.7	37				COUNTY	COUNTY
WKY	15	HANCOCK	012-060	2.3-3.7	37				COUNTY	COUNTY
WKY	15	DAVIESS	012-054	3.5-5.1	07	116-118			COUNTY	COUNTY
WKY	15	HANCOCK	012-048	3.5-5.1	37	116-118			COUNTY	COUNTY
WKY	15	OHIO	000-036						COUNTY	COUNTY
WKY	15	WEBSTER	027-029						COUNTY	COUNTY
WKY	15	BUTLER	000-036						COUNTY	COUNTY
WKY	15	EDMONDSON	024-048	1.7-4.3	10				COUNTY	COUNTY
WKY	15	GRAYSON	024-048	1.3-2.2	07				COUNTY	COUNTY
WKY	15	HART	000-048						COUNTY	COUNTY
WKY	15	WARREN	000-036	2.4-2.6	11				COUNTY	COUNTY
WKY	15	BUTLER	038-044	1.9-3.9	35	131-133			COUNTY	COUNTY
WKY	15	MUHLENBERG	036-048	1.8-2.0	35				COUNTY	COUNTY
WKY	15	WARREN		3.0-3.2	08	119-121	2180		COUNTY	COUNTY
WKY	15	MUHLENBERG	039-041	1.4-1.6	35	123-125			COUNTY	COUNTY
WKY	15	GRAYSON	000-024						COUNTY	COUNTY
WKY	15	EDMONDSON	000-036						COUNTY	COUNTY
WKY	15	GRAYSON	024-036						COUNTY	COUNTY
WKY	15	BUTLER	000-024						COUNTY	COUNTY
WKY	15	EDMONDSON							COUNTY	COUNTY

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STATE	SEAM NAME/NUMBER	COUNTY	THICKNESS	SULFUR	CONTENT	ASH	RTU	AST	FSI	TYPE	DATA
WKY	SCHULTZTOWN	CALDWELL	000-026							COUNTY	
WKY	SCHULIZIOTOWN	CHRISTIAN	000-026							COUNTY	
WKY	SCHULTZTOWN	DAVIESS	000-010							COUNTY	
WKY	SCHULIZIOTOWN	HOPKINS	000-026							COUNTY	
WKY	SCHULTZTOWN	UNION	002-004							COUNTY	
WKY	WHITE ASH	DAVIESS	000-036		0.8-4.0					COUNTY	
WKY	WHITE ASH	HANCOCK	000-048		0.7-2.3	06				COUNTY	

SUMMARY_BY_SEAM

STATE ILL

SEAM	AVG. (HUNDREDS OF BTU/LB.)	AVG. ASH (%)	AVG. AST (DEGREES F)
1	115	9	2052
2	118	9	2085
4	121	10	0
5	114	11	2042
6	113	11	2104
7	107	12	2074
8	0	0	0
ABINGDON	0	0	0
ASSUMPTION	116	10	0
BATTERY ROCK	0	0	0
BRIAR HILL	0	0	0
DAVIS	126	11	2285
DEKOVEN	120	10	2030
FRIENDSVILLE	107	11	0
INDIANA III	0	0	0
INDIANA IV	0	0	0
JACKSONVILLE	0	0	0
JAMESTOWN	0	0	0
LITCHFIELD	0	0	0
MAKANDA	0	0	0
MURPHYSBORO	128	8	2200
NEW BURNSTIDE	129	6	0
O NAN	0	0	0
OPDYKE	0	0	0
REYNOLDSBURG	0	0	0
SEAHORNE	0	0	0
SHAWNFETOWN	0	0	0
WILLIS	131	10	2070
THOMBRIDGE	92	21	0
WISE RIDGE	0	0	0

Summary of BTU, Ash and Ash Softening Temperature, (AST) by seam. Number of datum points vary. Zero(0) indicates no data collected. 1 As received. 2 Dry Basis.

Figure 5-16A.

SUMMARY BY SEAM

STATE IND

SEAM	AVG. (HUNDREDS OF BTU/LB.)	AVG. ASH (%)	AVG. AST (DEGREES F)
BLUE CREEK	115	6	2410
BRAZIL-U	106	17	2450
CANNELTON	120	3	0
COAL I	108	8	0
COAL IA	120	5	2650
COAL II	87	28	2140
COAL III	110	12	2180
COAL IIIA	107	12	2096
COAL IV	117	8	2222
COAL IVA	90	23	2205
COAL V	114	11	2117
COAL VA	0	0	0
COAL VB	103	18	2080
COAL VI	110	11	2151
COAL VII	109	11	2348
COAL VIIA	0	0	0
COHN	0	0	0
DALE	129	6	2085
DITNEY	101	20	2500
FAIRBANKS	83	27	2350
FRIDENSVILLE	106	11	0
HAZELTON BRIDGE	83	29	0
LOWER BLOCK	108	12	2448
MANSFIELD-U	109	11	2467
MARIAH HILL	111	12	1990
MC CLEARYS BLUFF	0	0	0
MINSHALL	106	11	2252
PARKER	76	36	0
SILVERWOOD	113	15	2150
STAUNTON-U	111	13	1960
UPPER BLOCK	107	10	2283

STATEWIDE SUMMARY IND

AVG. ASH CONTENTS= 14.47% PER SEAM
 AVG. BTU= 106.20 HUNDREDS OF BTU/LB. PER SEAM

SUMMARY BY SEAM

STATE WKY

SEAM	AVG. (HUNDREDS OF BTU/LB.)	AVG. ASH (%)	AVG. AST (DEGREES F)
18	131	7	2270
4	124	5	2055
5	0	0	0
6	117	10.	2106
7	127	11.	0
8	0	7	0
8B	0	0.	0
9	116	11	2178
10	122	11	1980
11	119	9	2181
12	114	12	2241
13	121	8	2116
14	118	9	2160
15	0	0	0
ABERDEEN	0	0	0
AMOS	0	0	0
BATTERY ROCK	0	0	0
BEITON	110	10	2040
DEANFIELD	0	0	0
DUNBAR	113	10	0
FOSTER	132	7.	0
HAWESVILLE	121	7	0
LEAD CREEK	0	7	0
LEWISPORT	117	7	0
LOWER OTTER CREEK	0	0	0
MAIN NOLIN	0	9	0
MINING CITY	126	6	2180
MUD RIVER	124	5	0
POTTSVILLE 2	0	0	0
POTTSVILLE 3	0	0	0
POTTSVILLE 4	0	0	0
SCHULTZTOWN	0	0	0
WHITE ASH	0	6	0

STATEWIDE SUMMARY WKY

AVG. ASH CONTENTS= 9.55% PER SEAM
 AVG. BTU= 120.96 HUNDREDS OF BTU/LB. PER SEAM

LOW SULFUR RESERVES(1.9%) or LESS GROUPED INTO CATEGORIES - ACCUMULATIVE

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 0.9 %

STATE	SEAM NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
ILL	6	WILLIAMSON	9S-1E	3	75	40
TOTAL RESERVES FOR THE STATE OF ILL			3.	MILLION TONS		

Figure 5-17 Cumulative summary of low sulfur coal reserves in place by sulfur category. A special report of reserves classified and categorized for higher sulfur classes has been provided by the Illinois Air Pollution Control Board. These data should be used in conjunction with the text portion of the report. This table should be used independently only after careful reference to study constraints and objectives.

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 0.9 %

STATE	SEAM NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	BLUE CREEK	MARTIN	2N-3W	3	26	55
IND	COAL I	PERRY	4S-3W	42	42	20
IND	COAL III	SULLIVAN	9N-8W	83	48	
IND	COAL IIIA	POSEY	6S-13W	0	14	
IND	COAL IVA	PCSEY	6S-13W	66	26	
IND	COAL V	SULLIVAN	8N-8W	88	72	180
IND	COAL V	SULLIVAN	8N-9W	191	65	230
IND	COAL VB	POSEY	8S-14W	0	20	
IND	COAL VI	POSEY	8S-14W	83	40	400
IND	COAL VII	KNOX	1N-10W	79	45	
IND	COAL VII	PCSEY	6S-13W	0	50	400
IND	COAL VII	POSEY	8S-14W	62	30	375
IND	COAL VII	SULLIVAN	7N-10W	80	36	300
IND	DITNEY	PCSEY	6S-13W	0	15	
IND	FAIRBANKS	SULLIVAN	9N-10W	100	31	08
IND	LOWER BLOCK	DUBOIS	3S-4W	0	14	
IND	LOWER BLOCK	GREENE	7N-6W	45	34	75
IND	LOWER BLOCK	GREENE	8N-6W	59	30	70
IND	LOWER BLOCK	OWEN	10N-5W	12	25	12
IND	LOWER BLOCK	SPENCER	4S-4W	76	28	
IND	MANSFIELD-U	DAVIESS	2N-5W	86	36	
IND	MANSFIELD-U	DUBOIS	1N-3W	1	30	35
IND	MINSHALL	FCUNTAIN	18N-9W	71	48	125
IND	PARKER	POSEY	6S-13W	0	6	
IND	UPPER BLOCK	CLAY	10N-6W	24	46	80
IND	UPPER BLOCK	GREENE	8N-5W	0	24	10
TOTAL RESERVES FOR THE STATE OF IND			1251.	MILLION TONS		
TOTAL RESERVES FOR THE STATE OF WKY			0.	MILLION TONS		

1/ More than one card prepared for unit areas suggests unit areas in which bimodal sulfur statistics were observed, e. g., where low sulfur-high boundary crossed.

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.4 %

STATE	SEAM NAME/NUMBER	CCOUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
ILL	MURPHYSBORO	JACKSON	8S-2W	52	32	149
ILL	MURPHYSBORO	JACKSON	9S-2W	40	48	50
ILL	2	WOODCFRD	28N-2E	105	32	550
ILL	6	FRANKLIN	5S-1E	93	96	664
ILL	6	FRANKLIN	7S-2E	4	102	410
ILL	6	FRANKLIN	7S-3E	28	96	550
ILL	6	MADISON	4N-7W	67	50	210
ILL	6	PERRY	6S-1W	19	75	250
ILL	6	WILLIAMSON	9S-1E	3	75	40

Total reserves for the state of Illinois 411 Million Tons

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.4 %

STATE	SFAM	NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	BLUE CREEK	DUPROIS		1N-6W	21	24	136
IND	BLUE CREEK	MARTIN		2N-3W	3	26	55
IND	BLUE CREEK	MARTIN		2N-4W	9	39	30
IND	COAL I	PERRY		4S-3W	42	42	20
IND	COAL IA	MARTIN		1N-3W	1	30	65
IND	COAL III	SULLIVAN		9N-8W	83	48	
IND	COAL IIIA	PARKE		14N-8W	0	20	
IND	COAL IIIA	PARKE		15N-9W	0	18	100
IND	COAL IIIA	PCSEY		6S-13W	0	14	
IND	COAL IV	CLAY		11N-7W	6	36	
IND	COAL IV	GREENE		7N-6W	112	36	50
IND	COAL IV	KNOX		5N-8W	124	46	300
IND	COAL IV	VERMILLION		14N-10W	93	48	275
IND	COAL IV	VIGO		12N-9W	110	60	275
IND	COAL IVA	CAVIESS		3N-6W	0	16	
IND	COAL IVA	PCSEY		6S-13W	66	26	
IND	COAL V	KNOX		2N-10W	121	36	350
IND	COAL V	SULLIVAN		8N-8W	88	72	180
IND	COAL V	SULLIVAN		8N-9W	191	65	230
IND	COAL V	SULLIVAN		9N-8W	122	75	70
IND	COAL VB	POSEY		7S-14W	0	20	
IND	COAL VB	POSEY		8S-14W	0	20	
IND	COAL VI	KNOX		3N-8W	92	60	85
IND	COAL VI	PCSEY		8S-14W	83	40	400
IND	COAL VI	SULLIVAN		9N-10W	154	61	200
IND	COAL VII	GRFENE		8N-7W	0	0	
IND	COAL VII	KNCX		1N-10W	79	45	
IND	COAL VII	KNCX		3N-8W	90	60	90
IND	COAL VII	POSEY		6S-13W	0	50	400
IND	COAL VII	PCSEY		8S-14W	62	30	375
IND	COAL VII	SULLIVAN		7N-10W	80	36	300
IND	COAL VII	SULLIVAN		8N-8W	19	54	50
IND	COAL VII	SULLIVAN		9N-9W	158	48	150
IND	DITNEY	POSEY		5S-13W	0	14	
IND	DITNEY	POSEY		6S-13W	0	15	
IND	FAIRBANKS	SULLIVAN		9N-10W	100	31	08
IND	LOWER BLOCK	DUBOIS		3S-4W	0	14	
IND	LOWER BLOCK	GREENE		7N-6W	45	34	75
IND	LOWER BLOCK	GREENE		8N-6W	59	30	70
IND	LOWER BLOCK	OWEN		10N-5W	12	25	12

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.4 %

STATE	SEAM NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	LOWER BLOCK	OWEN	10N-6W	19	48	25
IND	LOWER BLOCK	PARKE	14N-6W	10	42	65
IND	LOWER BLOCK	PARKE	15N-6W	106	34	147
IND	LOWER BLOCK	PARKE	15N-8W	2	48	150
IND	LOWER BLOCK	PARKE	17N-6W	37	24	
IND	LOWER BLOCK	SPENCER	4S-4W	76	28	
IND	MANSFIELD-U	DAVIESS	2N-5W	86	36	
IND	MANSFIELD-U	DUBOIS	1N-3W	1	30	35
IND	MARIAH HILL	DAVIESS	4N-5W	104	36	20
IND	MARIAH HILL	SPENCER	4S-5W	11	26	90
IND	MARIAH HILL	SPENCER	5S-4W	18	33	150
IND	MARIAH HILL	SPENCER	5S-5W	40	28	60
IND	MARIAH HILL	SPENCER	5S-6W	66	32	100
IND	MARIAH HILL	SPENCER	6S-4W	10	33	60
IND	MARIAH HILL	SPENCER	6S-5W	62	32	40
IND	MARIAH HILL	SPENCER	6S-6W	117	35	60
IND	MARIAH HILL	SPENCER	7S-5W	0	32	60
IND	MARIAH HILL	SPENCER	7S-6W	70	32	250
IND	MARIAH HILL	SPENCER	8S-6W	59	35	250
IND	MINSHALL	CLAY	12N-6W	2	30	40
IND	MINSHALL	FOUNTAIN	18N-9W	71	48	125
IND	MINSHALL	GREENE	8N-6W	0	20	24
IND	MINSHALL	MARTIN	1N-3W	5	48	20
IND	MINSHALL	PARKE	14N-6W	2	50	75
IND	MINSHALL	PARKE	15N-8W	17	48	130
IND	MINSHALL	SPENCER	4S-5W	6	27	22
IND	PARKER	POSEY	6S-13W	0	6	
IND	STAUNTON-U	GREENE	7N-6W	0	16	
IND	STAUNTON-U	PARKE	15N-6W	0	20	190
IND	UPPER BLOCK	CLAY	10N-6W	24	46	80
IND	UPPER BLOCK	CLAY	11N-6W	20	36	40
IND	UPPER BLOCK	CLAY	9N-6W	18	44	70
IND	UPPER BLOCK	FOUNTAIN	21N-8W	0	16	24
IND	UPPER BLOCK	GREENE	7N-6W	8	30	30
IND	UPPER BLOCK	GREENE	8N-5W	0	24	10
IND	UPPER BLOCK	PARKE	15N-8W	0	60	150
IND	UPPER BLOCK	PARKE	17N-7W	138	40	150

TOTAL RESERVES FOR THE STATE OF IND 3430. MILLION TONS

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.4 %

STATE	SEAM NAME/NUMBER	CCOUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
WKY 1B		UNION	62	14	36	360
WKY 4		CHRISTIAN	4	27	42	75

TOTAL RESERVES FOR THE STATE OF WKY 41. MILLION TONS

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.9 %

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
ILL	MURPHYSBORO	JACKSON	8S-2W	52	32	149
ILL	MURPHYSBORO	JACKSON	9S-2W	40	48	50
ILL	2	KNOX (1)	10N-3E	15	25	75
ILL	2	WILL (2)	32N-9E	9	36	70
ILL	2	WILL	33N-9E	29	36	35
ILL	2	WOODFORD	28N-2E	105	32	550
ILL	6	CLINTON	2N-5W	34	65	320
ILL	6	FRANKLIN	5S-1E	93	96	664
ILL	6	FRANKLIN	5S-2E	189	96	647
ILL	6	FRANKLIN	5S-3E	15	76	680
ILL	6	FRANKLIN	6S-2E	23	100	610
ILL	6	FRANKLIN	6S-3E	54	96	615
ILL	6	FRANKLIN	7S-2E	4	102	410
ILL	6	FRANKLIN	7S-3E	28	96	550
ILL	6	JACKSON (3)	7S-1W	45	84	150
ILL	6	JEFFERSON	3S-1E	65	87	750
ILL	6	JEFFERSON	3S-2E	142	84	850
ILL	6	JEFFERSON	4S-1E	145	97	800
ILL	6	JEFFERSON	4S-2E	250	84	800
ILL	6	JEFFERSON	4S-3E	63	66	700
ILL	6	MADISON	3N-7W	35	60	250
ILL	6	MADISON	4N-7W	67	50	210
ILL	6	PERRY	5S-1E	59	84	590
ILL	6	PERRY	5S-1W	17	60	125
ILL	6	PERRY	6S-1W	19	75	250
ILL	6	ST CLAIR (4)	1N-7W	32	84	150
ILL	6	WILLIAMSON	8S-1E	3	96	160
ILL	6	WILLIAMSON	8S-2E	3	96	150
ILL	6	WILLIAMSON	8S-3E	3	84	75
ILL	6	WILLIAMSON	9S-1E	3	75	40

TOTAL RESERVES FOR THE STATE OF ILL (5) 1641. MILLION TONS

- (1) J. Simon (written Communication, 1970) suggests sulfur content may be higher.
- (2) Extrapolated data from Grundy County. Maybe less low sulfur coal than suggested. Bureau of Mines data indicates coal in excess of 2.0%.
- (3) Little or no low sulfur coal according to Illinois State Geological Survey.
- (4) Illinois State Geological Survey Circular 432 shows principal reserves in 2N-7W, 2N-6W and 1N-6W, St. Clair County.
- (5) Saline County. No. 5 coal reported with sulfur content of 1.0-3.0%. Some low sulfur coal present, but unknown quantity <1.9%.

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.9 %

STATE	SEAM	NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	BLUE CREEK	DUBOIS		1N-6W	21	24	136
IND	BLUE CREEK	MARTIN		2N-3W	3	26	55
IND	BLUE CREEK	MARTIN		2N-4W	9	39	30
IND	BRAZIL-U	CLAY		13N-6W	123	50	
IND	COAL I	PERRY		4S-3W	42	42	20
IND	COAL IA	MARTIN		1N-3W	1	30	65
IND	COAL III	SULLIVAN	1	9N-8W	83	48	
IND	COAL IIIA	PARKE		15N-9W	0	18	100
IND	COAL IIIA	PARKE		15N-9W	0	18	10
IND	COAL IIIA	POSEY		6S-13W	0	14	
IND	COAL IV	CLAY		11N-7W	6	36	
IND	COAL IV	GREENE		7N-6W	112	36	50
IND	COAL IV	GREENE		7N-7W	84	54	132
IND	COAL IV	GREENE	1	8N-7W	77	60	145
IND	COAL IV	KNOX		5N-8W	124	46	300
IND	COAL IV	SULLIVAN		7N-8W	182	60	300
IND	COAL IV	VERMILLION		14N-10W	93	48	275
IND	COAL IV	VIGO		12N-9W	110	60	275
IND	COAL IV	VIGO		13N-9W	50	60	250
IND	COAL IVA	DAVIESS		3N-6W	0	16	
IND	COAL IVA	POSEY		6S-13W	66	26	
IND	COAL V	KNOX		2N-10W	121	36	350
IND	COAL V	PIKE	1	1N-7W	6	77	40
IND	COAL V	PIKE	1	1S-7W	63	56	50
IND	COAL V	SULLIVAN	1	8N-8W	88	72	180
IND	COAL V	SULLIVAN		8N-9W	191	65	230
IND	COAL V	SULLIVAN		9N-8W	122	75	70
IND	COAL V	WARRICK		6S-7W	8	60	60
IND	COAL VB	POSEY		7S-14W	0	20	
IND	COAL VB	POSEY		8S-14W	0	20	
IND	COAL VI	GREENE		7N-7W	2	65	75
IND	COAL VI	KNOX	1	3N-8W	92	60	85
IND	COAL VI	PCSEY		8S-14W	83	40	400
IND	COAL VF	SULLIVAN		9N-10W	154	61	200
IND	COAL VII	GREENE		7N-7W	2	48	35
IND	COAL VII	GREENE		8N-7W	0	0	
IND	COAL VII	KNOX		1N-10W	79	45	
IND	COAL VII	KNOX		3N-8W	90	60	90
IND	COAL VII	KNOX		5N-8W	84	40	70
IND	COAL VII	PIKE		1S-8W	52	40	25

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.9 %

STATE	SEAM	NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	COAL VII		POSEY	6S-13W	0	50	400
IND	COAL VII		PCSEY	8S-14W	62	30	375
IND	COAL VII		SULLIVAN	6N-8W	34	38	50
IND	COAL VII		SULLIVAN	7N-1CW	80	36	300
IND	COAL VII		SULLIVAN	8N-8W	19	54	50
IND	COAL VII		SULLIVAN	9N-8W	21	55	64
IND	COAL VII		SULLIVAN	9N-9W	158	48	150
IND	COAL VII		VIGO	10N-8W	25	42	63
IND	COAL VII		VIGO	10N-9W	123	40	63
IND	COAL VII		PCSEY	5S-13W	0	14	
IND	DITNEY		PCSEY	6S-13W	0	15	
IND	DITNEY		SULLIVAN	9N-10W	100	31	08
IND	FAIRBANKS		DUBOIS	3S-4W	0	14	
IND	LOWER BLOCK		GREENE	7N-6W	45	34	75
IND	LOWER BLOCK		GREENE	8N-6W	59	30	70
IND	LOWER BLOCK		OWEN	10N-5W	12	25	12
IND	LOWER BLOCK		OWEN	10N-6W	19	48	25
IND	LOWER BLOCK		PARKE	14N-6W	10	42	65
IND	LOWER BLOCK		PARKE	15N-6W	106	34	147
IND	LOWER BLOCK		PARKE	15N-8W	2	48	150
IND	LOWER BLOCK		PARKE	17N-6W	37	24	
IND	LOWER BLOCK		SPENCER	4S-4W	76	28	
IND	MANSFIELD-U		DAVIESS	2N-5W	86	36	
IND	MANSFIELD-U		DUBOIS	1N-3W	1	30	35
IND	MANSFIELD-U		DUBOIS	2S-5W	21	30	30
IND	MARIAH HILL		DAVIESS	4N-5W	104	36	20
IND	MARIAH HILL		SPENCER	4S-4W	29	34	30
IND	MARIAH HILL		SPENCER	4S-5W	11	26	90
IND	MARIAH HILL		SPENCER	5S-4W	18	33	150
IND	MARIAH HILL		SPENCER	5S-5W	40	28	60
IND	MARIAH HILL		SPENCER	5S-6W	66	32	100
IND	MARIAH HILL		SPENCER	6S-4W	10	33	60
IND	MARIAH HILL		SPENCER	6S-5W	62	32	40
IND	MARIAH HILL		SPENCER	6S-6W	117	35	60
IND	MARIAH HILL		SPENCER	7S-5W	0	32	60
IND	MARIAH HILL		SPENCER	7S-6W	70	32	250
IND	MARIAH HILL		SPENCER	8S-6W	59	35	250
IND	MINSHALL		CLAY	12N-6W	2	30	40
IND	MINSHALL		FCUNTAIN	18N-9W	71	48	125
IND	MINSHALL		FOUNTAIN	20N-7W	2	24	50

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.9 %

STATE	SEAM NAME/NUMBER	CCUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	MINSHALL	FOUNTAIN	20N-8W	137	60	75
IND	MINSHALL	GREENE	8N-6W	C	20	24
IND	MINSHALL	MARTIN	1N-3W	5	48	20
IND	MINSHALL	PARKE	14N-6W	2	50	75
IND	MINSHALL	PARKE	15N-8W	17	48	130
IND	MINSHALL	SPENCER	4S-5W	6	27	22
IND	PARKER	POSEY	6S-13W	0	6	
IND	STAUNTON-U	GREENE	7N-6W	0	16	
IND	STAUNTON-U	PARKF	15N-6W	0	20	190
IND	UPPER BLOCK	CLAY	10N-6W	24	46	80
IND	UPPER BLOCK	CLAY	11N-6W	20	36	40
IND	UPPER BLOCK	CLAY	9N-6W	18	44	70
IND	UPPER BLOCK	FCOUNTAIN	21N-8W	0	16	24
IND	UPPER BLOCK	GREENE	7N-6W	8	30	30
IND	UPPER BLOCK	GREENE	8N-5W	0	24	10
IND	UPPER BLOCK	GREENE	8N-6W	49	25	40
IND	UPPER BLOCK	OWEN	10N-5W	4	54	10
IND	UPPER BLOCK	OWEN	9N-6W	10	30	63
IND	UPPER BLOCK	PARKE	15N-8W	0	60	150
IND	UPPER BLOCK	PARKE	17N-7W	138	40	150
TOTAL RESERVES FOR THE STATE OF IND			4618.	MILLION TONS		

REPORT OF RESERVES COMPUTATION FOR TOTAL SULFUR CONTENT NOT GREATER THAN 1.9 %

STATE	SEAM NAME/NUMBER	CCOUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
WKY	DUNBAR	BUTLER	23	38	24	
WKY	MAIN NOLIN	EDMUNDSON	25	53	24	45 (6)
WKY	MINING CITY	MUHLENBERG	21	26 (9)	24	40
WKY	18	UNION	62	14	36	360
WKY	12 (7)	HENDERSON	87	0	22	180
WKY	12	OHIO	35	76	48	38 (10)
WKY	12	WEBSTER	46	30	48	250
WKY	12	WEBSTER	63	28	84	230
WKY	13 (8)	OHIO	35	38	48	105
WKY	13 (8)	OHIO	36	23	55	160
WKY	13	WEBSTER	46	62	40	269
WKY	4	CHRISTIAN	4	27	42	75
TOTAL RESERVES FOR THE STATE OF WKY			415.	MILLION TONS		

(6) Gilbert Smith (written communication, 1970) indicates thickness of overburden is greater. Study data suggests it does not exceed 80 feet.

(7) May be No. 13 coal.

(8) Some confusion exists as to whether this is No. 13 coal. Producer reports mining No. 13 coal, but Gilbert Smith (written communication, 1970) disagrees. Considerable difficulty experienced in differentiating No. 12 and No. 13 coal in some areas.

(9) Possibly in excess of reserves present.

(10) "Implied" level of confidence bases on study data. Gilbert Smith (written communication, (1970) questions reserves, and depth of overburden data.

the future may approach or exceed 194 billion tons defined in this study.

Averitt (1968) indicated (see Figure 5-15) additional resources amounting to 122 billion tons for Illinois and Indiana; data for Kentucky were not sub-totaled. Total available reserves, as estimated in this study, include coal in some of Averitt's "un-mapped and explored area."

The estimate of 50.7 billion tons for Indiana appears high when compared to Spencer, (1953), or Wier and Hutchinson, (1970) but approaches the 56,779 million tons suggested by Averitt.³ It is presumed that reserves computed for Indiana may be high because the lenticular or discontinuous character of many Indiana coals; this may produce an over-estimation in reserves when extrapolating mean thickness data over a large area. In addition, most thickness values come from areas where coal was mined, i.e., where seams are best developed and quite thick.

In many areas of the MWCF, e.g., Hancock County, Kentucky, estimates include coal reserves which may not be large enough to support extensive operations by present standards. Such assessments are, however, based largely on economic assessments and outside the scope of geological availability.

5.3.2 County Data Summary

Sulfur and ash content, thermal value, ash softening temperature (AST) and Free Swelling Index (FSI) data have been prepared by seam and county (Figure 5-16). Thermal (BTU), ash and ash softening temperatures by seam have been summarized in Figure 5-16A.

Values are not intended to express absolute minimum and maximum values but are representative minimum and maximum values where the coal has been mined or is exposed on outcrops.

In some instances, unit area data was subject to so many limitations that preparation of a corresponding (summary) county sheet could not be justified.

County data have been prepared in machine readable form.

5.3.3 Unit Area Data Summary

Total available reserves have been categorized in this study by sulfur content in machine readable form. Reserves categorized by sulfur category up to 1.9% are shown in Figure 5-17.

As previously indicated, certain problems have been introduced by analytic procedures.

In some areas generally believed to have low sulfur (1.9% or less) coals, the weight of statistical data resulted in final values of 2.0 or 2.1% being assigned. Thus, while maintaining a consistent procedure of data analysis, certain low sulfur areas were thus eliminated from reserves estimated in this report.

5.4 AVAILABLE⁴ LOW SULFUR COAL RESERVES

5.4.1 Natural Low Sulfur Reserves

Natural low sulfur coal is defined as that coal in place which, with minimum preparation, has a sulfur content of 1.9% or less as mined.

Natural low sulfur coal reserves are estimated to amount to 6,674 million tons in the MWCF (Figure 5-18) or 3,075 million tons of strip coal and 3,599 million tons of deep coal and are summarized by seam for unit area (Figure 5-19) and county (Figure 5-20). The geographical distribution of natural low sulfur coal regardless of seam is shown in Figures 5-21 and 5-22; for maps showing sulfur distribution by seam, see pocket.

Reserves by seam and sulfur category and by sulfur - depth of overburden categories are tabulated in Appendix C, Table 1 and Table 2. Note that these values are based on raw data in the machine data bank alone, without supplementary geological analysis and updating.

Strip/deep coal values are based on interpretation of geological data in order to supplement mean thickness of overburden data. Strip/data reserves computations are based on machine analysis of coal resources data alone, i.e., without further data analysis to fill data gaps.

Some low sulfur coals in the 1.0 - 1.9% sulfur classes (Figure 5-23) can be subjected to additional cleaning --- thus increasing reserves in the less than 0.9% and 1.0 - 1.4% sulfur categories by 112 million and 1,173 million tons respectively (Figure 5-24).

That the natural (and cleaned) low sulfur reserve estimates in this report are not intended for producer use; that these data may be limited by data availability and method of computation is worthy of additional emphasis.

For example, in Indiana, low sulfur coal may be found in relatively local (possibly thin and discontinuous) seams, and which were assumed to be relatively continuous based on best available (but possibly undesirable) data. Some reserve over-estimates can, therefore, be anticipated.

Mr. Charles Wier (written communication, 1970) indicated an appreciation for the re-emphasizing of the problems of accepting low sulfur reserve estimates in Indiana. Regarding the estimates of 4618 million tons of low sulfur (<1.9%) coal for Indiana and based on study results, Dr. Wier wrote:

"You list Coal VII in about 15 different townships as being low in sulfur. I agree that in many places Coal VII does contain less than 2 percent of sulfur. In Knox County your list shows 79 million tons of coal in T. 1N., R. 10 W. This I presume is based on an analysis from a core of coal obtained from the Geological Survey. A few miles to the north, but in the next township north, we drilled another hole and the sulfur in Coal VII was 4 percent. You surely would agree that if our legislators, through anti-pollution laws (should not) tell a coal com-

4 All reserves are total in-place unless otherwise indicated. Recoverability will be considered later.

3 Less reserves mined out or lost to mining.

STATE	TOTAL NATURAL LOW SULFUR COAL	TOTAL STRIP COAL*	TOTAL DEEP COAL*
ILLINOIS	1641	168	1473
INDIANA	4618	2949	1969
WEST KENTUCKY	415	258	157
TOTAL ALL STATES	6674	3375	3599

Figure 5-18. Summary of natural low sulfur reserves by state. Estimates (*) for strip and deep coal include data from supplementary geological interpretation. This table should be used independently only after careful reference to study objectives and constraints.

REPORT OF RESERVES COMPUTATION SHOWING SULFUR CATEGORY

PAGE NO. 1

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	SZPYR	SZORG	SZTOT	SZCLN	THKNS	OVERBURDEN
ILL	MURPHYSBORO	JACKSON	8S-2W	52	1.0-1.4			1.4		32	145
ILL	MURPHYSBORO	JACKSON	9S-2W	40	1.0-1.4			1.2		48	50
ILL	2	KNOX	10N-3E	15	1.5-1.9	C.4	1.4	1.8		25	75
ILL	2	WILL	32N-9E	9	1.5-1.9			1.9		36	70
ILL	2	WILL	33N-9E	29	1.5-1.9	1.9	0.7	1.8		36	35
ILL	2	WOODFORD	28N-2E	105	1.0-1.4	0.6	0.7	1.2		32	550
ILL	6	CLINTON	2N-5W	34	1.5-1.9			1.5		65	320
ILL	6	FRANKLIN	5S-1E	93	1.0-1.4	C.6	0.6	1.3	0.9	96	664
ILL	6	FRANKLIN	5S-2E	189	1.5-1.9	C.7	0.7	1.5	1.1	96	647
ILL	6	FRANKLIN	5S-3E	15	1.5-1.9			1.5		76	680
ILL	6	FRANKLIN	6S-2E	23	1.5-1.9			1.9	1.2	100	610
ILL	6	FRANKLIN	6S-3E	54	1.5-1.9	1.3	0.7	1.8		96	615
ILL	6	FRANKLIN	7S-2E	4	1.0-1.4	C.6	0.5	1.1	1.0	102	410
ILL	6	FRANKLIN	7S-3E	28	1.0-1.4			1.4		96	550
ILL	6	JACKSON	7S-1W	45	1.5-1.9			1.7	1.4	84	150
ILL	6	JEFFERSON	3S-1E	65	1.5-1.9	1.9	0.5	1.5	1.3	87	750
ILL	6	JEFFERSON	3S-2E	142	1.5-1.9	1.9	0.5	1.5	1.3	84	850
ILL	6	JEFFERSON	4S-1E	145	1.5-1.9	C.8	0.7	1.5	1.2	97	800
ILL	6	JEFFERSON	4S-2E	250	1.5-1.9	1.9	0.7	1.6	1.2	84	800
ILL	6	JEFFERSON	4S-3E	63	1.5-1.9			1.6		66	700
ILL	6	MADISON	3N-7W	35	1.5-1.9	1.2	0.7	1.8	1.5	60	250
ILL	6	MADISON	4N-7W	67	1.0-1.4			1.1		50	210
ILL	6	PERRY	5S-1E	59	1.5-1.9			1.5		84	590
ILL	6	PERRY	5S-1W	17	1.5-1.9			1.5		60	125
ILL	6	PERRY	6S-1W	19	1.0-1.4			1.1		75	250
ILL	6	ST CLAIR	1N-7W	32	1.5-1.9			1.5		84	150
ILL	6	WILLIAMSON	8S-1E	3	1.5-1.9			1.9		96	160
ILL	6	WILLIAMSON	8S-2E	3	1.5-1.9	1.9	0.5	1.5	1.1	96	150
ILL	6	WILLIAMSON	8S-3E	3	1.5-1.9	1.3	0.7	1.9	1.5	84	75
ILL	6	WILLIAMSON	9S-1E	3	0.0-0.9			0.6		75	40
TOTAL RESERVES FOR THE STATE OF ILL				1641	MILLION TONS						

Figure 5-19. Natural low sulfur coal reserves by seam and unit area. Favorable stripping ratio indicated by dot(.). Supplementary thickness of overburden data is indicated by a dash (-). It is not suggested all reserves estimated are mineable. Table should be used independently only after careful reference to study objectives and constraints.

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	\$PYR	\$ORG	\$TOT	\$CLM THKNS	OVERBURDEN
IND	BLUE CREEK		CUBOIS	1N-6W	21	1.0-1.4			1.4	24	136
IND	BLUE CREEK		MARTIN	2N-3W	3	0.0-0.9			0.8	26	55
IND	BLUE CREEK		MARTIN	2N-4W	9	1.0-1.4			1.0	39	30
IND	BRASIL-L		CLAY	13N-6W	123(1) (*)	1.5-1.9			1.7	50	110
IND	CUAL I		PERRY	4S-3W	42 (*)	0.0-0.9			0.9	42	20
IND	COAL IA		MARTIN	1N-3W	1	1.0-1.4			1.0	30	65
IND	COAL III		SULLIVAN	9N-8W	83 (*)	0.0-0.9			0.6	48	200
IND	COAL IIIA		PARKE	15N-9W	0	1.0-1.4			1.3	18	100
IND	COAL IIIA		PARKE	15N-9W	0	1.0-1.4			1.3	18	100
IND	COAL IIIA		POSEY	6S-13W	0	0.0-0.9			0.7	14	650
IND	COAL IV		CLAY	11N-7W	6	1.0-1.4			1.0	36	25
IND	COAL IV		GREENE	7N-6W	112	1.0-1.4		0.8	1.1	36	50
IND	COAL IV		GREENE	7N-7W	84	1.5-1.9		0.6	1.6	54	132
IND	COAL IV		GREENE	8N-7W	77	1.5-1.9			1.7	60	145
IND	COAL IV		KNOX	5N-8W	124 (*)	1.0-1.4			1.0	46	300
IND	COAL IV		SULLIVAN	7N-8W	182	1.5-1.9	1.0	0.9	1.9	60	300
IND	COAL IV		VERMILLION	14N-10W	93	1.0-1.4			1.1	48	275
IND	COAL IV		VIGO	12N-9W	110 (*)	1.0-1.4			1.0	60	275
IND	COAL IV		VIGC	13N-9W	50	1.5-1.9	1.0	0.5	1.5	60	250
IND	COAL IVA		DAVISS	3N-6W	0	1.0-1.4			1.3	16	100
IND	COAL IVA		POSEY	6S-13W	66	0.0-0.9			0.8	26	600
IND	COAL V		KNOX	2N-10W	121 (*)	1.0-1.4			1.1	36	350
IND	COAL V		PIKE	1N-7W	6	1.5-1.9			1.9	77	40
IND	COAL V		PIKE	1S-7W	63	1.5-1.9			1.8	56	50
IND	COAL V		SULLIVAN	8N-8W	88	0.0-0.9			1.9	72	180
IND	COAL V		SULLIVAN	8N-9W	191	0.0-0.9	0.2	0.5	0.8	65	230
IND	COAL V		SULLIVAN	9N-8W	122 (*)	1.0-1.4			1.3	75	70
IND	COAL V		WARRICK	6S-7W	8	1.5-1.9			1.8	60	60
IND	COAL VB		POSEY	7S-14W	0	1.0-1.4			1.4	20	500
IND	COAL VB		POSEY	8S-14W	0	0.0-0.9			0.8	20	420
IND	COAL VI		GREENE	7N-7W	2	1.5-1.9			1.6	48	35
IND	COAL VI		KNOX	3N-8W	92	1.0-1.4	1.1	0.8	1.9	65	75
IND	COAL VI		POSEY	8S-14W	83	0.0-0.9			0.8	60	85
IND	COAL VI		SULLIVAN	9N-10W	154 (*)	1.0-1.4			1.3	61	400
IND	COAL VII		GREENE	7N-7W	2	1.5-1.9			1.6	48	200
IND	COAL VII		GREENE	8N-7W	0	1.0-1.4			1.2	40	70
IND	COAL VII		KNOX	1N-10W	79	0.0-0.9	0.6	0.6	0.7	45	75
IND	COAL VII		KNOX	3N-8W	90	1.0-1.4			1.2	60	90
IND	COAL VII		KNOX	5N-8W	84	1.5-1.9			1.5	40	70
IND	COAL VII		PIKE	1S-8W	52	1.5-1.9	1.9	0.8	1.7	40	25

(1) Reserve data at implied level of confidence based on a thickness in excess of 36". believes value is too high.

(2) Reserves probably less than indicated due to limited quantities of available thickness and coal quality data. Largely implied level of confidence. Information limited. Weir (personal communication, 1970)

(3) Insufficient data to map areal extent. Reserves estimate may be high.

REPORT OF RESERVES COMPUTATION SHOWING SULFUR CATEGORY

PAGE NO. 3

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S*PYR	S*ORG	S*TOT	S*CLN THKMS	OVERBURDEN
IND	QUAL VII	POSEY	6S-13W	0	C.0-0.9			0.8	50	400
IND	QUAL VII	POSEY	8S-14W	62	0.0-0.9			0.9	30	375
IND	QUAL VII	SULLIVAN	6N-8W	34	1.5-1.9	1.9	0.7	1.6	1.3	50
IND	QUAL VII	SULLIVAN	7N-10W	80	0.0-0.9			0.9	36	300
IND	QUAL VII	SULLIVAN	8N-8W	19	1.0-1.4			1.0	54	50
IND	COAL VII	SULLIVAN	9N-8W	21	1.5-1.9	C.7	1.9	1.6	55	64
IND	COAL VII	SULLIVAN	9N-9W	158	1.0-1.4	C.6	0.8	1.4	48	150
IND	COAL VII	VIGO	10N-8W	25	1.5-1.9	C.6	1.3	1.9	42	63
IND	COAL VII	VIGO	10N-9W	123	1.5-1.9	C.7	1.9	1.7	40	63
IND	CITNEY	POSEY	5S-13W	0	1.0-1.4			1.2	14	400
IND	CITNEY	POSEY	6S-13W	0	0.0-0.9			0.7	15	400
IND	FAIRBANKS	SULLIVAN	9N-10W	100	0.0-0.9			0.7	31	8
IND	LOWER BLOCK	DUBOIS	3S-4W	0	C.0-0.9			0.3	14	40
IND	LOWER BLOCK	GREENE	7N-6W	45	0.0-0.9			0.8	34	75
IND	LOWER BLOCK	GREENE	8N-6W	59	0.0-0.9			0.8	30	70
IND	LOWER BLOCK	CWEN	10N-5W	12	0.0-0.9			0.8	25	12
IND	LOWER BLOCK	CWEN	10N-6W	19	1.0-1.4			1.1	48	25
IND	LOWER BLOCK	PARKE	14N-6W	10	1.0-1.4			1.0	42	65
IND	LOWER BLOCK	PARKE	15N-6W	106(2)	1.0-1.4			1.1	34	147
IND	LOWER BLOCK	PARKE	15N-8W	2	1.0-1.4			1.2	48	150
IND	LOWER BLOCK	PARKE	17N-6W	37	1.0-1.4			1.0	24	150
IND	LOWER BLOCK	SPENCER	4S-4W	76	0.0-0.9			0.7	28	15
IND	MANSFIELD-U	CAVIESS	2N-5W	86	0.0-0.9			0.7	36	20
IND	MANSFIELD-U	DUBOIS	1N-3W	1	0.0-0.9			0.5	30	35
IND	MANSFIELD-U	DUBOIS	2S-5W	21	1.5-1.9			1.7	30	30
IND	MARIAH HILL	CAVIESS	4N-5W	104(2)	1.0-1.4			1.3	36	20
IND	MARIAH HILL	SPENCER	4S-4W	29	1.5-1.9			1.9	34	30
IND	MARIAH HILL	SPENCER	4S-5W	11	1.0-1.4			1.0	26	90
IND	MARIAH HILL	SPENCER	5S-4W	18(*)	1.0-1.4			1.0	33	150
IND	MARIAH HILL	SPENCER	5S-5W	40(*)	1.0-1.4			1.0	28	60
IND	MARIAH HILL	SPENCER	5S-6W	66(*)	1.0-1.4			1.0	32	100
IND	MARIAH HILL	SPENCER	6S-4W	10(*)	1.0-1.4			1.0	33	60
IND	MARIAH HILL	SPENCER	6S-5W	62(*)	1.0-1.4			1.0	32	40
IND	MARIAH HILL	SPENCER	6S-6W	117(2)	1.0-1.4			1.0	35	60
IND	MARIAH HILL	SPENCER	7S-5W	0	1.0-1.4			1.0	32	60
IND	MARIAH HILL	SPENCER	7S-6W	70(*)	1.0-1.4			1.0	32	250
IND	MARIAH HILL	SPENCER	8S-6W	59(*)	1.0-1.4			1.0	35	250
IND	MINSHALL	CLAY	12N-6W	2	1.0-1.4	1.0	0.3	1.2	30	40
IND	MINSHALL	FOUNTAIN	18N-9W	71(*)	0.0-0.9			1.9	48	125
IND	MINSHALL	FOUNTAIN	20N-7W	2	1.5-1.9			1.6	24	50

REPORT OF RESERVES COMPUTATION SHOWING SULFUR CATEGORY

PAGE NO. 4

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S&PYR	S&ORG	S&TOT	S&CLN	THKNS	OVERBURDEN
IND	MINSHALL	FOUNTAIN	20N-8W	137(1)	1.5-1.9			1.6		60	75
IND	MINSHALL	GREENE	8N-6W	0	1.0-1.4			1.0		20	24
IND	MINSHALL	MARTIN	1N-3W	5	1.0-1.4			1.0		48	20
IND	MINSHALL	PARKE	14N-6W	2	1.0-1.4			1.1		50	75
IND	MINSHALL	PARKF	15N-8W	17	1.0-1.4			1.1		48	130
IND	MINSHALL	SPENCER	4S-5W	6	1.0-1.4			1.3		27	22
IND	PARKER	POSEY	6S-13W	0	0.0-0.9			0.6		6	300
IND	STAUNTON-U	GREENE	7N-6W	0	1.0-1.4			1.4		16	36
IND	STAUNTON-U	PARKE	15N-6W	0	1.0-1.4			1.1		20	190
IND	UPPER BLOCK	CLAY	10N-6W	24	0.0-0.9			1.9		46	80
IND	UPPER BLOCK	CLAY	11N-6W	20	1.0-1.4	1.0	0.4	1.3		36	40
IND	UPPER BLOCK	CLAY	9N-6W	18	1.0-1.4	0.7	0.8	1.2		44	70
IND	UPPER BLOCK	FOUNTAIN	21N-8W	0	1.0-1.4			1.4		16	24
IND	UPPER BLOCK	GREENE	7N-6W	8	1.0-1.4			1.0		30	30
IND	UPPER BLOCK	GREENE	8N-5W	0	0.0-0.9			0.6		24	10
IND	UPPER BLOCK	GREENE	8N-6W	49	1.5-1.9	0.7	0.8	1.5	1.4	25	40
IND	UPPER BLOCK	CWEN	10N-5W	4	1.5-1.9			1.5		54	10
IND	UPPER BLOCK	CWEN	9N-6W	10	1.5-1.9	0.7	0.8	1.5	1.4	30	63
IND	UPPER BLOCK	PARKF	15N-8W	0	1.0-1.4			1.4		60	150
IND	UPPER BLOCK	PARKF	17N-7W	138(3)	1.0-1.4			1.0		40	150
TOTAL RESERVES FOR THE STATE OF IND				4618.	MILLION TONS (4) (5)						

(4) Some overestimates have probably been introduced because of the lenticular character of some Indiana coals, and because thickness data reflects mined (thicker) coals. Indiana State Geological Survey normally halves known area to account for thickness variations in lenticular coals. Analysis of Indiana coals limited by lack of sulfur data as indicated by asterix.

(*) Very few sulfur datum points available for analysis. More data will be required to prove-out reserves.

(5) No data was made available concerning development of low sulfur coal reserves in Gibson County, Indiana (and adjacent parts of Illinois).

REPORT OF RESERVES COMPUTATION SHOWING SULFUR CATEGORY

PAGE NO. 5

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S&PYR	S&ORG	S&TOT	S&CLN	THKNS	OVERBURDEN
WKY	CUNBAR	BUTLER	23	38	1.5-1.9			1.8		24	75
WKY	MAIN NO. 11A	EDMONDSON	26	53	1.5-1.9			1.7		24	45
WKY	MINING CITY	MUHLENBERG	21	26	1.5-1.9			1.9		24	40
WKY	18	UNION	62	14	1.0-1.4			1.1		36	36C
WKY	12	HENDERSON	87	0	1.5-1.9			1.8		22	180
WKY	12	OHIO	35	76	1.5-1.9			1.5		48	38
WKY	12	WEBSTER	46	30	1.5-1.9			1.6		48	250
WKY	12	WEBSTER	63	28	1.5-1.9			1.6		84	23C
WKY	13	CHIC	35	38	1.5-1.9	C.8	1.0	1.8	1.6	48	105
WKY	13	CHIC	36	23	1.5-1.9	C.8	1.0	1.8	1.6	55	16C
WKY	13	WEBSTER	46	62	1.5-1.9			1.8		40	265
WKY	4	CHRISTIAN	4	27	1.0-1.4			1.3		42	75

TOTAL RESERVES FOR THE STATE OF WKY 415. MILLION TONS

State	Seam	County	Strippable Reserves	Deep Reserves	Reserves by Seam and County	Total Reserves (by Seam)
Illinois	Murphysboro	Jackson	92	--	92	92
Illinois	2	Knox	15	--	15)	158
Illinois	2	Will	38	--	38)	
Illinois	2	Woodford	--	105	105)	
Illinois	6	Clinton	--	34	34)	
Illinois	6	Franklin	--	406	406)	1391
Illinois	6	Jackson	--	45	45)	
Illinois	6	Jefferson	--	665	665)	
Illinois	6	Madison	--	102	102)	
Illinois	6	Perry	17	78	95)	
Illinois	6	St. Clair	--	32	32)	
Illinois	6	Williamson	6	6	12)	
Total State of Illinois				1473 (5)	1641	1641

Figure 5-20. Natural low sulfur coal reserves by seam and county. (Millions of tons) This table should be used independently only after careful reference to study objectives and constraints.

- (5) Low sulfur, deep coal reserves reported in Saline County but quantity of coal reserves less than 1.9% cannot be determined.

State	Seam	County	Strippable Reserves	Deep Reserves	Reserves by seam and county	Total Reserves (by seam)
Indiana	Blue Creek	Dubois	21	-	21)	33
"	Blue Creek	Martin	12	-	12)	
"	Brazil-U	Clay	123	-	123	123
"	Coal I	Perry	42	-	42	42
"	Coal IA	Martin	1	-	1	1
"	Coal III	Sullivan	-	83	83	83
"	Coal IIIA	Parke	Neg	-	Neg	Neg
"	Coal IIIA	Posey	-	Neg	Neg	Neg
"	Coal IV	Clay	6	-	6)	838
"	Coal IV	Greene	273	-	273)	
"	Coal IV	Knox	-	124	124)	
"	Coal IV	Sullivan	-	182	182)	
"	Coal IV	Vermillion	-	93	93)	
"	Coal IV	Vigo	-	160	160)	
"	Coal IVA	Daviess	Neg	-	Neg)	
"	Coal IVA	Posey	-	66	66)	66
"	Coal V	Knox	-	121	121)	599
"	Coal V	Pike	69	-	69)	
"	Coal V	Sullivan	122	279	401)	
"	Coal V	Warrick	8		8)	Neg
"	Coal VB	Posey	-	Neg	Neg	
"	Coal VI	Greene	2	-	2)	331
"	Coal VI	Knox	92	-	92)	
"	Coal VI	Posey	-	83	83)	
"	Coal VI	Sullivan	-	154	154)	

State	Seam	County	Strippable Reserves	Deep Reserves	Reserves by seam and county	Total Reserves (by seam)
Indiana	Coal VII	Greene	2	-	2)	829
"	Coal VII	Knox	253	-	253)	
"	Coal VII	Pike	52	-	52)	
"	Coal VII	Posey	-	62	62)	
"	Coal VII	Sullivan	74	238	312)	
"	Coal VII	Vigo	148	-	148)	366
"	Ditney	Posey	-	Neg	Neg	
"	Fairbanks	Sullivan	100	-	100	
"	Lower Block	Dubois	Neg	-	Neg	
"	Lower Block	Greene	104	-	104)	
"	Lower Block	Owen	31	-	31)	108
"	Lower Block	Parke	116	39	155)	
"	Lower Block	Spencer	76	-	76)	
"	Mansfield-U	Daviess	86	-	86)	
"	Mansfield-U	Dubois	22	-	22)	
"	Mariah Hill	Daviess	104	-	104)	586
"	Mariah Hill	Spencer	335	147	482)	
"	Minshall	Clay	2	-	2)	
"	Minshall	Fountain	210	-	210)	
"	Minshall	Greene	Neg	-	Neg)	
"	Minshall	Martin	5	-	5)	242
"	Minshall	Parke	19	-	19)	
"	Minshall	Spencer	6	-	6)	
"	Parker	Posey	-	Neg	Neg	
"	Staunton-U	Greene	Neg	-	Neg)	
"	Staunton-U	Parke		Neg	Neg)	Neg

State	Seam	County	Strippable Reserves	Deep Reserves	Reserves by seam and county	Total Reserves (by seam)
Indiana	Upper Block	Clay	62	-	62)	271
"	Upper Block	Fountain	Neg	-	Neg)	
"	Upper Block	Greene	57	-	57)	
"	Upper Block	Owen	14	-	14)	
"	Upper Block	Parke	-	138	138)	
			2649	1969	4618	4618

State	Seam	County	Strippable Reserves	Deep Reserves	Reserves by seam and county	Total Reserves (by seam)
West Kentucky	Dunbar	Butler	38	-	38	38
"	Main Nolin	Edmondson	53	-	53	53
"	Mining City	Muhlenberg	26		26	26
"	1B	Union	-	14	14	14
"	12	Henderson	-	-	0)	
"	12	Ohio	76	-	76)	134
"	12	Webster	-	58	58)	
"	13	Ohio	38	23	61)	
"	13	Webster	-	62	62)	123
"	4	Christian	27	-	27	27
Total			258	157	415	415

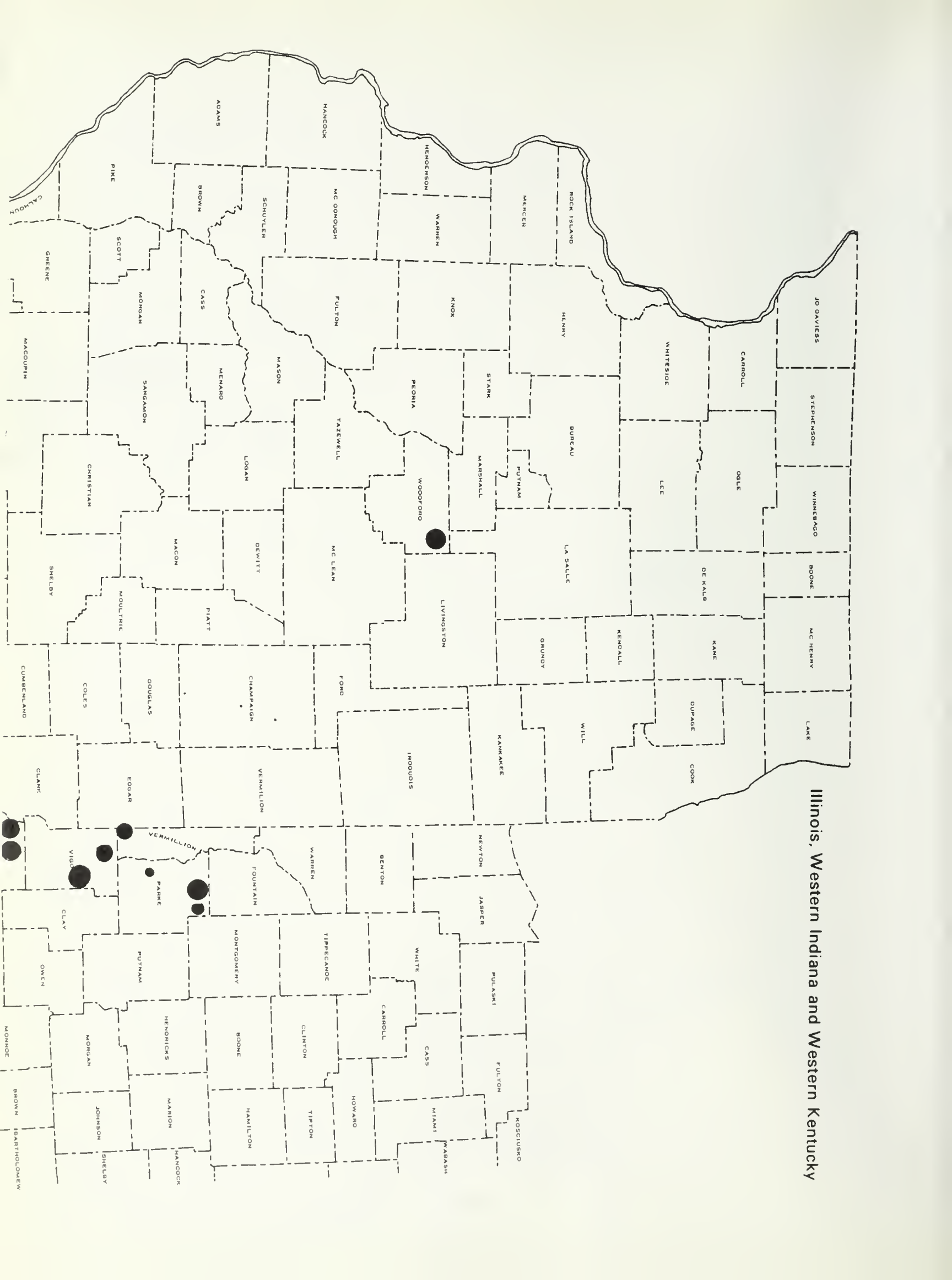
Deep natural low sulfur coal

study objectives and constraints.



Legend (See Fig. 5-30 for legend)

Figure 5-22. Deep natural low sulfur coal reserves in place. Independent use of this map should include careful reference to study objectives and constraints.

[illegible]

Low Sulphur Reserves by Class			
(Millions of Tons)			
States	0.9%	0.9-1.4%	1.5-1.9%
Illinois	3 ⁶	411	1,230
Indiana	1,251	2,179	1,188
West Kentucky	-	41	374
All States by Sulphur Category	1,254	2,631	2,792

Figure 5-23 Summary of Natural Low Sulphur Reserves (millions of tons) by Sulphur Category. Table should be used independently only after careful reference to study constraints.

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6. Additional but unconfirmed reserves in excess of 100 million tons may occur in Macoupin County, Illinois based on data after Gluskoter and Simon (1968)

State	Seam	County	Unit Area	Strip Reserves	Deep Reserves
Illinois					
"	6	Franklin	55-1E	-	93
"	6	Franklin	55-2E	-	189
"	6	Franklin	65-2E	-	23
"	6	Jackson	75-1W	-	45
"	6	Jefferson	35-1E	-	65
"	6	Jefferson	35-2E	-	142
"	6	Jefferson	45-1E	-	145
"	6	Jefferson	45-2E	-	250
"	6	Williamson	85-2E	-	3
Total State of Illinois				-	955
Indiana					
"	IV	Greene	7N-7W	84	-
"	IV	Vigo	13N-9W	-	50
"	V	Pike	1S-7W	63	-
"	VII	Sullivan	6N-8W	34	-
"	VII	Sullivan	8N-8W	19	-
"	VII	Sullivan	9N-8W	21	-
"	Upper Block	Greene	8N-6W	49	-
"	Upper Block	Owen	9N-6W	10	-
Total State of Indiana				280	50
West Kentucky					
				-	-
TOTAL ALL STATES				280	1005

Figure 5-24. Low sulfur coals which with cleaning could increase reserves in < 0.9 or 1.0-1.4% sulfur classes.

Table should be used independently only after careful reference to study constraints.

Reserves by seam and county	Total Sulfur %	Cleaned Sulfur %	Added Reserves 0-0.9%	Added Reserves 1.0-1.4%
93	1.3	0.9	93	-
	1.5	1.1	-	189
212	1.9	1.2	-	23
45	1.7	1.4	-	45
	1.5	1.3	-	65
602	1.5	1.3	-	142
	1.6	1.2	-	145
	1.6	1.2	-	250
3	1.5	1.1	-	3
955			93	862
84	1.6	1.0	-	84
50	1.5	1.0	-	50
63	1.8	1.4	-	63
	1.6	1.3	-	34
74	1.0	0.6	19	-
	1.6	1.3	-	21
49	1.5	1.4	-	49
10	1.5	1.4	-	10
330			19	311
			-	-
1285			112	1173

pany that they must quit producing 3 or 4 percent-sulfur coal and produce a less than 2 percent sulfur coal from this township on the basis of one analysis for 36 square miles..... Probably a similar situation exists in other townships. I do not know how many analysis you had on Coal VII in T. 5N., R. 8W., although I would expect very few. We do have in our file in the next township north analysis from 3 small strip mines in Coal VII which show an as received sulfur percent as 2.8, 3.3 and 4.5. The main point I am trying to make here is that while your system of summarizing things by township units will likely give a good ball park figure it does not begin to account for the local variation. Surely, high sulfur townships have some low sulfur coal and low sulfur townships have high sulfur coal; with this mixture there must be only a limited number of areas where the low sulfur is continuous enough to allow for a mine to operate only in that low sulfur area. The normal situation would be for a mine to operate in low sulfur coal in some areas and high sulfur in others.

Your system does, of course, have one significant bias. The largest amount of data is available in the areas of most intensive mining or in areas that have been closely drilled in preparation for mining. Thus, the bulk of the data comes from the economic viewpoint, and thus from those coals that are thickest, shallowest, highest in BTU and lowest in ash and sulfur."

J. Simon (written communication, 1970) indicated that low sulfur No. 5 coal in Saline County less than 1.9% should be included but based on this study's data it was not possible to determine the quantity of coal less than 2.0%. He further noted that too little attention was given several low sulfur coal areas noted in Gluskoter and Simon (1968), and that probable low sulfur No. 5 coal reported by Hopkins (1968) was not evaluated. In some such instances, available (i.e., not confidential) producer data conflicted and data validation was not possible. Such observations are important in that they suggest additional reserves which may increase estimates made in the study for the State of Illinois.

Factors Influencing Availability⁷

Recoverability

Reserves of strip coal that can be recovered with present technology are summarized in Figure 5-25 and for deep coal in Figure 5-26. These data are conservative, i.e., they are based on data consolidated from open sources without the benefit of further geological interpretation of thickness of overburden data. Estimates below include additional reserves identified following geological analysis of low sulfur reserve statistics.

A total of 3,953 million tons of low sulfur coal (Figure 5-25) to be recoverable over the MWCF is estimated using current technology. More strip re-

serves are recoverable than deep reserves, with 86% (1854) of all recoverable strip coal in Indiana.

Other Factors

Recoverability alone is not, however, a fully satisfactory indicator of availability. Quasi-geological factors such as quality, stripping ratio, expansion of existing mining operations, and geological condition which might introduce potential coking coals into the air pollution control market must be evaluated.

Geological experience indicates that not all defined strippable (150 feet) low sulfur coals will in fact be stripped; the stripping ratio (thickness of overburden to seam thickness) is one criterion used to assess strippability. To a large degree, it is a measure of near-term availability, because producers mine thick seams under shallow overburden first. Most coals with a favorable stripping ratio are in Indiana (Figure 5-27).

Other problems can be anticipated which impact near-term availability. For example, switching from natural high sulfur (3.7%) No. 6 coal from the Fulton County, Illinois area to natural low sulfur (1.5%) No. 6 coal from Franklin-Jefferson County, Illinois area would result in a nearly 50% increase in transportation distance for sale in the Chicago market.

The increased transportation costs are aggravated by the inverse relationship existing between the sulfur content and ash-softening (or fusion) temperature⁸, i.e., as sulfur content declines, ash fusion temperature increases. This creates problems in collection of solid wastes, and can require furnace redesign. Furthermore, if total ash content (which determines the capacity of fly-ash precipitators or other ash handling equipment) increases from 8 percent to 11 percent, about a 37 percent increase in the total volume of ash results. The loss of thermal value obviously has cost implications to many industries.

Strippable Low Sulfur Reserves

The adoption of a 25:1 (or less) stripping ratio would increase the estimate of low sulfur reserves in place; although the average ratio for the MWCF may be less than 25:1 for many years. Averitt (1968) indicated that in Illinois ratios larger than 30:1 have been handled for large-scale stripping operations where the coal is 28-36 inches thick. Risser (personal communication, 1970) agreed that a 25:1 ratio was feasible for future low sulfur strip mining, assuming a price increase in low sulfur coal. Furthermore, the maximum strip ratio is increasing based on data supplied Resser (1969).

8 On July 28, 1969, A. Gerber, Senior Consultant of National Economic Research Associates, Inc. (NERA), published a paper on Air Pollution and the Use of Low Sulfur Coal. He indicated switching to coal with a lower sulfur content (but higher ash fusion temperature) may cause serious heat exchange and slag tapping problems in wet-bottom boilers. These boilers are usually designed to operate at a relatively low ash-fusion temperature range and require that the ash remain sufficiently fluid to flow out through the slag-tap openings over a substantial portion of the load range. This requirement is easily upset by switching to coal with a higher fusion temperature. AST is commonly divided into the following classes: (a) class 1 - refractory ash softening above 2600°F, (b) class 2 - medium fuseable ash, softening between 2200-2600°F, (c) class 3 - easily fuseable ash, softening below 2200°F. AST temperatures for coals in the MWCF are largely in the easily fuseable class 3. Indiana and West Kentucky coals fall more commonly into class 2, than do Illinois coals.

7 Many factors could limit availability such as closely spaced faulting or heavily-drilled areas. However, they have already been eliminated from total available reserves.

Total Low Sulfur Reserves		Raw Data		Raw Data with Supplementary Geological Analysis		Geological Analysis		
		Total Strip in place	Total Deep in place	Total Strip in place	Total Strip in place	Recoverable Strip	Recoverable Deep	Total Recoverable
Illinois	1641	168	1473	168	1473	118	736	854
Indiana	4618	2329	1783	2649	1969	1854	985	2839
West Kentucky	415	220	157	258	157	181	79	260
Total All States	6674	2717	3413	3075	3599	2153	1800	3953

Figure 5-25. Recoverable natural low sulfur reserves for the MWCf. Table should be used independently only after careful reference to text description of data collection constraints.

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
III		MURPHYSBORO	JACKSON	8S-2W	36	32	149
III		MURPHYSBORO	JACKSON	9S-2W	28	48	50
III	2		KNOX	ION-3E	10	25	75
III	2		WILL	32N-9E	7	36	70
III	2		WILL	33N-9E	20	36	35
III	6		PERRY	5S-1W	12	60	125
III	6		WILLIAMSON	8S-3E	2	84	75
III	6		WILLIAMSON	9S-1E	2	75	40

TOTAL RESERVES FOR THE STATE OF ILL 117. MILLION TONS

Figure 5-25A.- Strippable natural low sulfur reserves which are recoverable at 70%. Based on machine data alone, total reserves for all states amount to 1864 million tons. This table should be used independently only after careful reference to study objectives and constraints.

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	BLUE CREEK		DUBOIS	1N-6W	15	24	136
IND	BLUE CREEK		MARTIN	2N-3W	2	26	55
IND	BLUE CREEK		MARTIN	2N-4W	7	39	30
IND	COAL I		PERRY	4S-3W	29	42	20
IND	COAL IA		MARTIN	1N-3W	1	30	65
IND	COAL IIIA		PARKE	15N-9W	0	18	100
IND	COAL IIIA		PARKE	15N-9W	0	18	100
IND	COAL IV		GREENE	7N-6W	78	36	50
IND	COAL IV		GREENE	7N-7W	59	54	132
IND	COAL IV		GREENE	8N-7W	54	60	145
IND	COAL V		PIKE	1N-7W	4	77	40
IND	COAL V		PIKE	1S-7W	44	56	50
IND	COAL V		SULLIVAN	9N-8W	85	75	70
IND	COAL V		WARRICK	6S-7W	5	60	60
IND	COAL VI		GREENE	7N-7W	2	65	75
IND	COAL VI		KNOX	3N-8W	64	60	85
IND	COAL VII		GREENE	7N-7W	1	48	35
IND	COAL VII		KNOX	3N-8W	63	60	90
IND	COAL VII		KNOX	5N-8W	59	40	70
IND	COAL VII		PIKE	1S-8W	37	40	25
IND	COAL VII		SULLIVAN	6N-8W	24	38	50
IND	COAL VII		SULLIVAN	8N-8W	13	54	50
IND	COAL VII		SULLIVAN	9N-8W	15	55	64
IND	COAL VII		VIGO	10N-8W	17	42	63
IND	COAL VII		VIGO	10N-9W	86	40	63

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP (cont.)

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	FAIRBANKS		SULLIVAN	9N-10W	70	31	8
IND	LOWER BLOCK		GREENE	7N-6W	31	34	75
IND	LOWER BLOCK		GREENE	8N-6W	41	30	70
IND	LOWER BLOCK		OWEN	10N-5W	8	25	12
IND	LOWER BLOCK		OWEN	10N-6W	13	48	25
IND	LOWER BLOCK		PARKE	14N-6W	7	42	65
IND	LOWER BLOCK		PARKE	15N-6W	74	34	147
IND	MANSFIELD-U		DUBOIS	1N-3W	1	30	35
IND	MANSFIELD -U		DUBOIS	2S-5W	15	30	30
IND	MARIAH HILL		DAVIESS	4N-5W	73	36	20
IND	MARIAH HILL		SPENCER	4S-4W	20	34	30
IND	MARIAH HILL		SPENCER	4S-5W	8	26	90
IND	MARIAH HILL		SPENCER	5S-5W	28	28	60
IND	MARIAH HILL		SPENCER	5S-6W	46	32	100
IND	MARIAH HILL		SPENCER	6S-4W	7	33	60

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
IND	MARIAH HILL		SPENCER	6S-5W	43	32	40
IND	MARIAH HILL		SPENCER	6S-6W	82	35	60
IND	MARIAH HILL		SPENCER	7S-5W	0	32	60
IND	MINSHALL		CLAY	12N-6W	1	30	40
IND	MINSHALL		FOUNTAIN	18N-9W	50	48	125
IND	MINSHALL		FOUNTAIN	20N-7W	1	24	50
IND	MINSHALL		FOUNTAIN	20N-8W	96	60	75
IND	MINSHALL		GREENE	8N-6W	0	20	24
IND	MINSHALL		MARTIN	1N-3W	3	48	20
IND	MINSHALL		PARKE	14N-6W	1	50	75
IND	MINSHALL		PARKE	15N-8W	12	48	130
IND	MINSHALL		SPENCER	4S- 5W	4	27	22
IND	UPPER BLOCK		CLAY	10N-6W	17	46	80
IND	UPPER BLOCK		CLAY	11N-6W	14	36	40
IND	UPPER BLOCK		CLAY	9N-6W	13	44	70
IND	UPPER BLOCK		FOUNTAIN	21N- 8W	0	16	24
IND	UPPER BLOCK		GREENE	7N-6W	6	30	30
IND	UPPER BLOCK		GREENE	8N-5W	0	24	10
IND	UPPER BLOCK		GREENE	8N-6W	34	25	40
IND	UPPER BLOCK		OWEN	10N-5W	3	54	10
IND	UPPER BLOCK		OWEN	9N-6W	7	30	63

TOTAL RESERVES FOR THE STATE OF IND 1593. MILLION TONS

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS OVERBURDEN
WKY	MAIN	NOLIN	EDMONDSON	26	37	24
WKY	MINING	CITY	MUHLENBERG	21	18	24
WKY	12		OHIO	35	53	48
WKY	13		OHIO	35	27	48
WKY	4		CHRISTIAN	4	19	42

TOTAL RESERVES FOR THE STATE OF WKY 154. MILLION TONS

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
III	2		WOODFORD	28N-2E	53	32	550
III	6		CLINTON	2N-5W	17	65	320
III	6		FRANKLIN	5S-1E	46	96	664
III	6		FRANKLIN	5S-2E	95	96	647
III	6		FRANKLIN	5S-3E	7	76	680
III	6		FRANKLIN	6S-2E	12	100	610
III	6		FRANKLIN	6S-3E	27	96	615
III	6		FRANKLIN	7S-2E	2	102	410
III	6		FRANKLIN	7S-3E	14	96	550
III	6		JACKSON	7S-1W	23	84	150
III	6		JEFFERSON	3S-1E	32	87	750
III	6		JEFFERSON	3S-2E	71	84	850
III	6		JEFFERSON	4S-1E	73	97	800
III	6		JEFFERSON	4S-2E	125	84	800
III	6		JEFFERSON	4S-3E	32	66	700
III	6		MADISON	3N-7W	18	60	250
III	6		MADISON	4N-7W	34	50	210
III	6		PERRY	5S-1E	29	84	590
III	6		PERRY	6S-1W	10	75	250
III	6		ST. CLAIR	1N-7W	16	84	150
III	6		WILLIAMSON	8S-1E	2	96	160
III	6		WILLIAMSON	8S-2E	2	96	150

TOTAL RESERVES FOR THE STATE OF ILL 740. MILLION TONS

Figure 5-26. - Deep natural low sulfur reserves which are recoverable at 50%. Based on machine data without supplementary geological analysis. Total recoverable reserves for all states amount to 1709 million tons. This table should be used independently only after careful reference to study objectives and constraints.

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES(MILLION TONS)	THKNS	OVERBURDEN
IND	COAL IV		KNOX	5N-8W	62	46	300
IND	COAL IV		SULLIVAN	7N-8W	91	60	300
IND	COAL IV		VERMILLION	14N-10W	47	48	275
IND	COAL IV		VIGO	12N-9W	55	60	275
IND	COAL IV		VIGO	13N-9W	25	60	250
IND	COAL V		KNOX	2N-10W	60	36	350
IND	COAL V		SULLIVAN	8N-8W	44	72	180
IND	COAL V		SULLIVAN	8N-9W	95	65	230
IND	COAL VI		POSEY	8S-14W	41	40	400
IND	COAL VI		SULLIVAN	9N-10W	77	61	200
IND	COAL VII		POSEY	6S-13W	0	50	400
IND	COAL VII		POSEY	8S-14W	31	30	375
IND	COAL VII		SULLIVAN	7N-10W	40	36	300
IND	COAL VII		SULLIVAN	9N-9W	79	48	150
IND	LOWER BLOCK		PARKE	15N-8W	1	48	150
IND	MARIAH HILL		SPENCER	5S-4W	9	33	150
IND	MARIAH HILL		SPENCER	7S-6W	35	32	250
IND	MARIAH HILL		SPENCER	8S-6W	29	35	250
IND	STAUNTON - U		PARKE	15N-6W	0	20	190
IND	UPPER BLOCK		PARKE	15N-8W	0	60	150
IND	UPPER BLOCK		PARKE	17N-7W	69	40	150

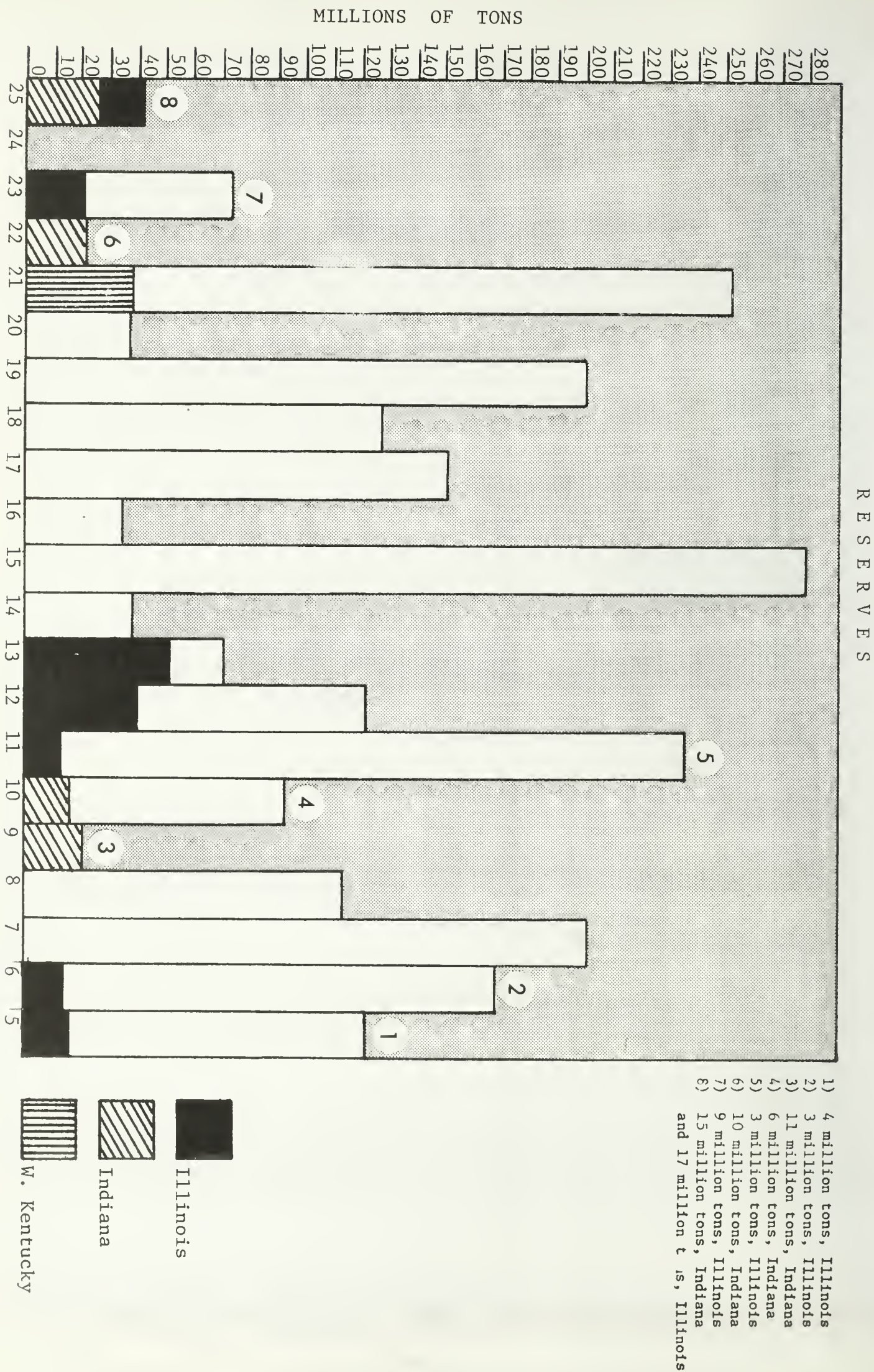
TOTAL RESERVES FOR THE STATE OF IND 890. MILLION TONS

REPORT OF RESERVES COMPUTATION FOR TOWNSHIP

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	THKNS	OVERBURDEN
WKY	1B		UNION	62	7	36	360
WKY	12		HENDERSON	87	0	22	180
WKY	12		WEBSTER	46	15	48	250
WKY	12		WEBSTER	63	14	84	230
WKY	13		OHIO	36	12	55	160
WKY	13		WEBSTER	46	31	40	269

TOTAL RESERVES FOR THE STATE OF WKY 79. MILLION TONS

Figure 5-27. Stripping Ratio. Independent use of this figure should include careful reference to study objectives and constraints.



INDIANA

State	Seam	County	Total Strippable Reserves	Strippable Reserves with favorable stripping ratio *
Indiana	Blue Creek	Dubois	21	
Indiana	Blue Creek	Martin	12	12
"	Brazil-U	Clay	123	
"	Coal I	Perry	42	42
"	Coal IA	Martin	1	
"	Coal IV	Clay	6	6
"	Coal IV	Greene	273	112
"	Coal V	Pike	69	69
"	Coal V	Sullivan	122	122
"	Coal V	Warrick	8	8
"	Coal VI	Greene	2	2
"	Coal VI	Knox	92	92
"	Coal VII	Greene	2	2
"	Coal VII	Knox	253	253
"	Coal VII	Pike	52	52
"	Coal VII	Sullivan	74	74
"	Coal VII	Vigo	148	148
"	Fairbanks	Sullivan	100	100
"	Lower Block	Greene	104	
"	Lower Block	Owen	31	31
"	Lower Block	Parke	116	10
"	Lower Block	Spencer	76	76
"	Mansfield-U	Daviess	86	86
"	Mansfield-U	Dubois	22	22
"	Mariah Hill	Daviess	104	104
"	Mariah Hill	Spencer	335	218
"	Minshall	Clay	2	2

State	Seam	County	Total Strippable Reserves	Strippable Reserves with favorable stripping ratio
Indiana	Minshall	Fountain	210	139
Indiana	Minshall	Martin	5	5
"	Minshall	Parke	19	2
"	Minshall	Spencer	6	6
"	Upper Block	Clay	62	62
"	Upper Block	Greene	57	57
"	Upper Block	Owen	14	14
			2649	1928

WEST KENTUCKY

State	Seam	County	Total Strippable Reserves	Strippable Reserves with favorable stripping ratio*
	Dunbar	Butler	38	—
West Kentucky	Main Nolin	Edmondson	53	53
"	Mining City	Muhlenberg	26	26
"	12	Ohio	76	76
"	13	Ohio	38	
"	4	Christian	27	27
Total State of West Kentucky			258	182

Favorable stripping ratios depend upon a variety of interrelated geological-economic factors, including thickness and quality of the coal, density and hardness of the overburden, capacity of machinery, size of property, and distance to transportation facilities and markets.

Computation of stripping ratios do not take into account the possibility of mining two or more seams separated by a small stratigraphic interval which could limit availability. For example, in Ohio County (Paradise Quadrangle) West Kentucky, the No. 11 and 12 coals might be stripped together. Such stripping could, however, result in the mixing of low and relatively high sulfur reserves unless special (and possibly costly) mining procedures were used. In Indiana where the Lower Block and Upper Block coals are often mined together, between 400-450 million tons of natural low sulfur coal may be intermixed with high sulfur coal during mining and are thus lost as low sulfur reserves.

Expansion of strip mine operations, assuming land availability, appears to be a feasible near term alternative to the more difficult prospect of deep mine development. Accessibility of operating mines in (or adjacent to) low sulfur reserves has, therefore, been used as a second criterion of availability. This assumes equipment already committed to on-going production needs can be rapidly moved to exploit low sulfur seams.

Available natural low sulfur (strip) coals with a favorable strip ratio (25:1 or greater) are estimated to amount to 101 million tons in place in Illinois (Figure 5-29). In view of the relative speed with which strip mining can be undertaken under favorable stripping conditions, this is a more reasonable measure of near-term reserves availability than total strippable reserves. The geographic distribution of natural low sulfur (strip) coal reserves with a favorable stripping ratio is seen in Figure 5-30.

The exploitation of strippable low sulfur reserves to serve Illinois will require the opening of new strip mines through the MWCF and particularly in Indiana. For example, the Minshall (Buffaloville) Coal is presently being worked only in Spencer County, Indiana where less than 3% (6 million tons) of the total low sulfur Minshall reserves have been identified.

Whether adjacent (i.e., within the township) land will actually be available for stripping is, however, difficult to ascertain. Risser (1960) suggested that:

"The problem of future reserves of strip coal will not be as much one of scarcity as of availability...The problem, east of the Mississippi, at least, will be one of piecing together coal and surface rights to make a block sufficiently large for an economical operation."

Approximately 8% (12 million tons) of strippable value low sulfur reserves in Illinois (Figure 5-31) are probably accessible to exploration by extension of current strip operations, although more significant quantities of accessible reserves can be found in Indiana and West Kentucky (Figure 5-32).

Deep Low Sulfur Reserves

Similarly, a significant criterion in assessing the availability of deep low sulfur reserves is ac-

cessibility to current deep mining operations. Even under the most favorable conditions of accessibility, exploitation of even these deep reserves is probably not a near-term possibility because of the time required to open new underground mines. Intensive geological studies must be undertaken to assemble the necessary precursor data required by new safety standards. The reopening of presently inactive deep mines in low sulfur reserves would also prove a lengthy process precluding near-term availability.

Less than one-third (427 million tons) of deep natural low sulfur reserves in place in Illinois (Figure 5-33) are in proximity (within unit area) to current deep mining operations.

Thus, despite the presence of significant low sulfur coal reserves, geological or production factors may prove the most significant determinants of deep mine development. For example, after geological engineering (and parallel economic) studies, it was decided that a low sulfur (1.6% sulfur) mine near Troy, Illinois would not be opened. The producer reported that:

"...the mine could not be opened or operated economically and coal produced in the mine could not compete in the St. Louis non-utility market. Gas will displace coal from the non-utility market which the Troy mine was intended to serve."

Other problems which discouraged development of this mine were:

"...adverse mining conditions in the area, including hazardous roof and floor conditions, which would result in high mining costs."

Furthermore, published reports suggest that the coal was not competitive as a steam coal; presumably, high production costs could not be offset by introducing some of the coal produced into the metallurgical coke market.

Prior underground mining in some areas increases the difficulty of mining low sulfur reserves and, therefore, limits future availability. For example, No. 12 low sulfur coal reserves in West Kentucky probably include large tonnages lying immediately above the No. 11 coal underground mine workings. Recovery of the No. 12 seam is judged to be difficult or impossible under these conditions, and reserve estimates for the No. 12 coal in some areas are deceptive when compared to actual recoverability. Mining of deep low sulfur Kentucky No. 12 coal reserves amounting to 134,000,000 tons may be limited locally by the presence of such underlying mine operations.

Most deep low sulfur reserves in Illinois currently being mined are concentrated in the Herrin No. 6 seam in the Franklin-Jefferson-Williamson County "Quality Circle". Some low sulfur reserves in this area are, however, in (a) relatively isolated small (5 million tons or less) blocks, and (b) coal split by sedimentary rocks. Exploitation (and availability) of deep reserves throughout the MWCF will be limited if the coal occurs in relatively small blocks where it is difficult (and costly) to recover. Gluskoter and Simon (1968) indicated that the "split coal" (split into two or more benches by many feet of siltstone and shale) although low in sulfur content, has been the subject of only limited mining due to difficult mining conditions.

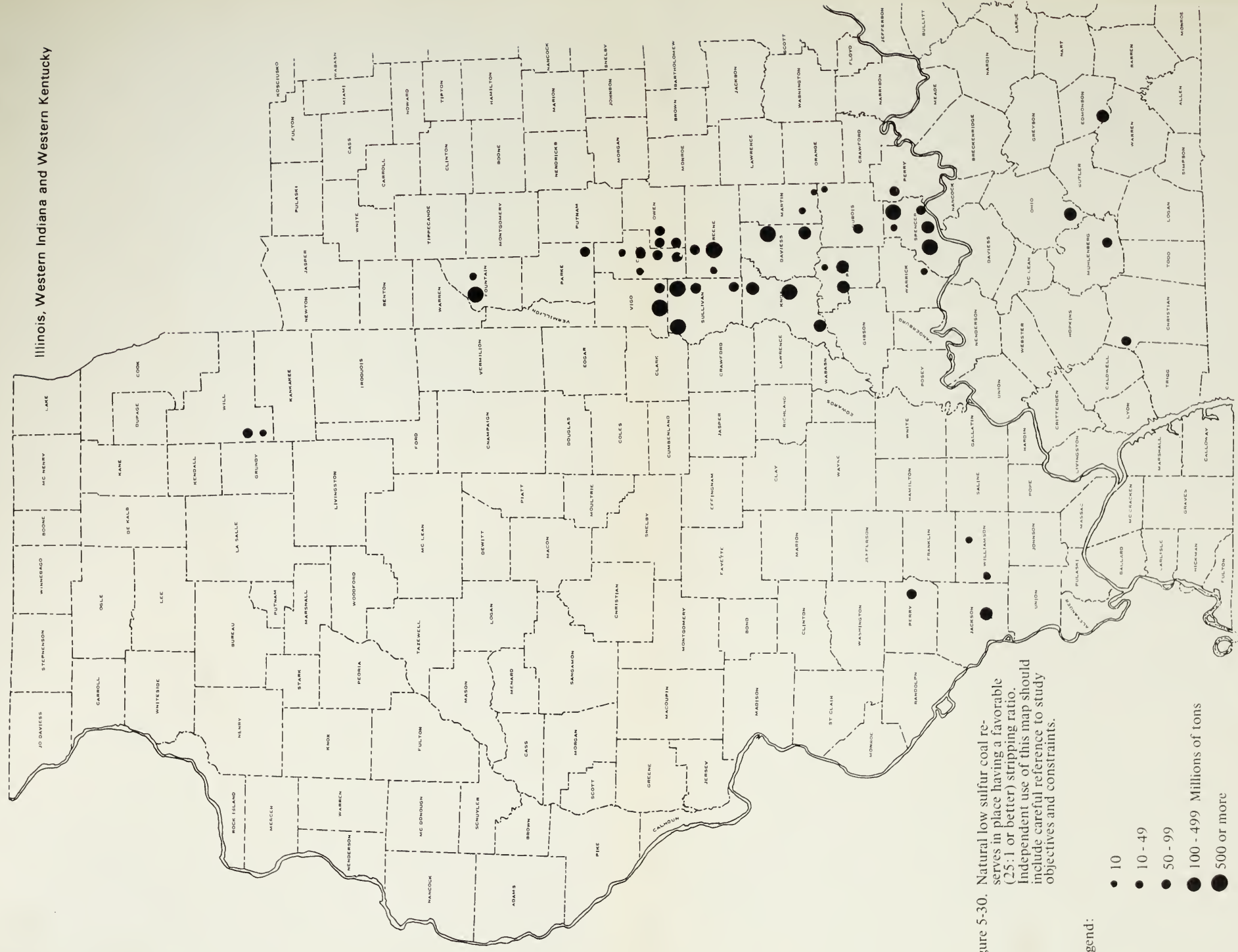
ILLINOIS

State	Seam	County	Total Strippable Reserves ⁹	Strippable Reserves with Favorable Stripping Ratio
Illinois	Murphysboro	Jackson	92	40
Illinois	2	Knox	15	--
Illinois	2	Will	38	38
Illinois	6	Perry	17	17
Illinois	6	Williamson	6	6
Total State of Illinois			168	101

Figure 5-29

Summary of strippable 150 feet coal reserves, millions of tons, having a favorable stripping ratio in Illinois, Indiana and West Kentucky. Table should be used independently only after careful reference to study objectives and constraints.

⁹ Additional reserves included in the following geological analysis to fill data gaps.



Seam	County	Total Reserves (Strip)	AVAILABLE ¹⁰		UNAVAILABLE
			Favorable stripping ratio of 25:1 or less	Accessible to commercial mining operations	Unfavorable stripping ratio of 25:1 or less
Murphysboro	Jackson	92	40	9	52
2	Knox	15	-	-	15
2	Will	38	38	-	-
6	Perry	17	17	-	-
6	Williamson	6	6	3	-
TOTALS		168	101	12	67

Figure 5-31. Estimated remaining strip (natural) low sulfur reserves in Illinois versus geologically related parameters to assess availability for exploitation. This table should be used independently only after careful reference to study objectives and constraints.

¹⁰ Values are estimates based on analysis of regional maps and producer information.

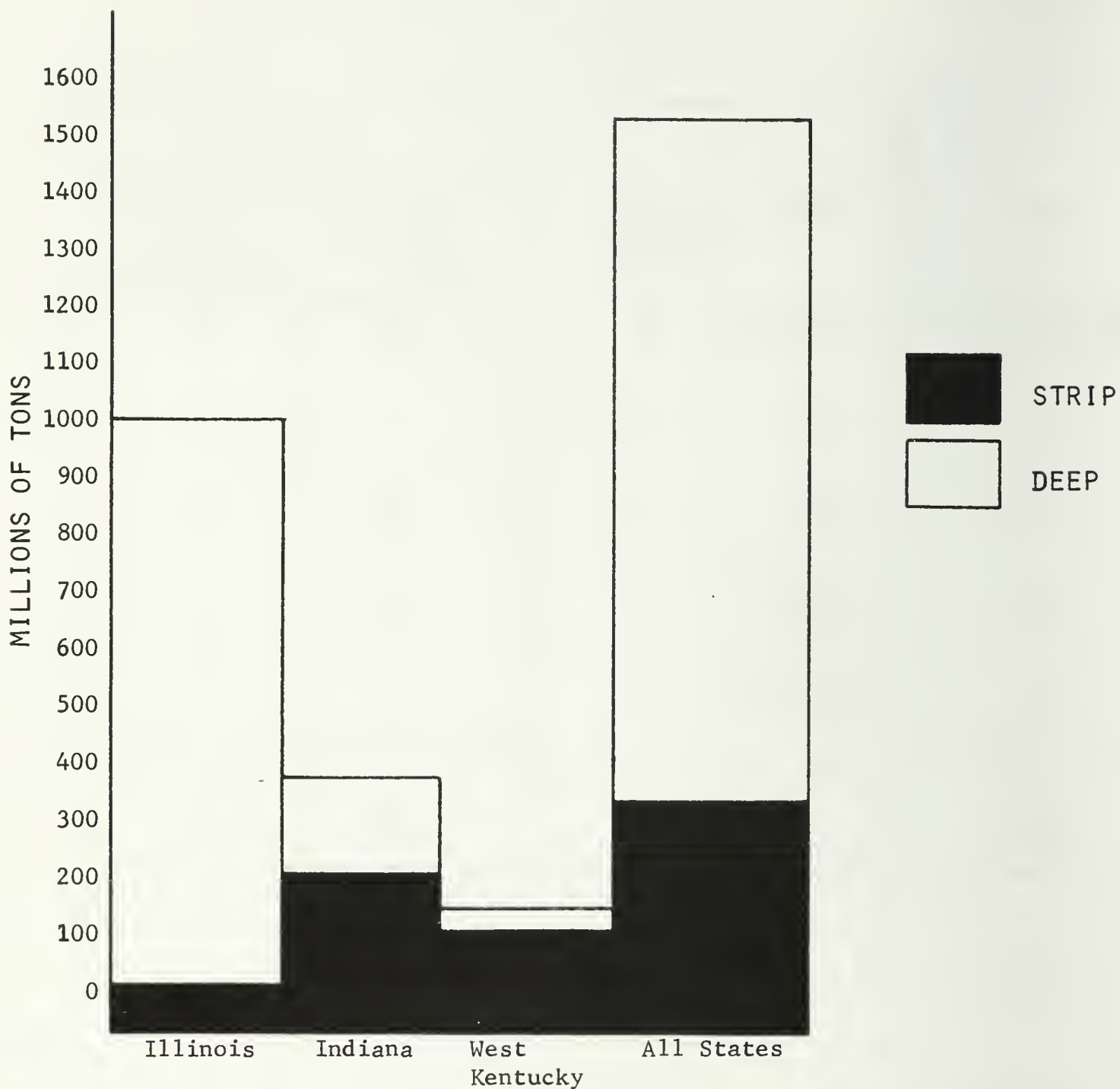


Figure 5-32. Estimate of natural low sulphur reserves accessible to areas of current production. Reserves estimates assume rights to nearby reserves can be obtained. Figure should be used independently only after careful reference to study objectives and constraints.

Estimates of the impact of these factors in Illinois available natural low sulfur coal reserves are shown in Figure 5-33. Based on these criteria, approximately one-third (496 million tons) are probably available for air pollution control purposes assuming competition for low sulfur coal by the steel industry would be strongest for best quality coking coal. There are few mines operating in deep low sulfur reserves, and the time required to develop new mines will limit the near-term availability of deep coals.

5.4.2 Low Sulfur-Cleaned Reserve

Low sulfur-cleaned coals are high sulfur coals which have favorable cleaning properties including (1) an organic sulfur content less than 2.0% and (2) pyrite in a form¹² (e.g., large nodules or fissure fillings) which permits the coal to be cleaned (washed) to a lower sulfur products.

Low sulfur coal availability could be increased if some of the high sulfur coals being produced could be desulfurized prior to combustion. Limited attention has been given reserves of low sulfur-cleaned coals in the past because of a general lack of published data on cleaned coals, e.g., type of cleaning. Basic data are summarized in Figure 5-34. A total of 1,420 million tons of low sulfur-cleaned coals (in-place reserves) have been identified over the MWCF (Figure 5-35), the majority (994 million tons) of which are concentrated in Illinois. Less than 10% (124 million tons) are strippable over the MWCF all of which are found in Indiana. Reserves in West Kentucky were estimated at 116 million tons. It should be noted¹³ that coal quality data was limited for some seams in which additional low sulfur-cleaned reserves might be found. Specifically, in the Dawson Springs and St. Charles Quadrangles, reserves of No. 4 coal in the 2.2% cleaned sulfur category might, with additional cleaning, be reduced to a less than 2.0% sulfur content, thus nearly doubling defined low sulfur-cleaned reserves.

The Federal Power Commission (1968) has indicated that there is practically no coal east of the Mississippi that could be mechanically upgraded to meet the proposed standards for SO₂ emissions from Federal facilities without treatment of the stack effluent. This was based on the fact that the organic sulfur content of practically all of these coals, which cannot be removed from coal by mechanical methods, is greater than the allowable total sulfur content. Furthermore, not all pyrite can be removed without a significant decrease in yield.

11 Of the 1956 million tons of deep low sulfur coal identified in Illinois, it must be emphasized that there is no assurance that reserves, regardless of size, difficulty of mining or geological character, will be used to fill an expanding utility market if competitive opportunities to exploit them for more profitable metallurgical grade coal development.

12 In conventional coal preparation processes, the larger pyritic particles are removed since the pyrite has a much greater density than coal. However, in order to be separated during the cleaning operation, the pyrite must first be released from the coal substances; much of the pyrite in coals occurs in finely disseminated particles and is not usually removed. The size distribution of pyrite varies from seam and even within a given seam or mine so that generalizations about its physical properties are difficult.

13 In particular, the No. 4 and No. 6 seams have been locally used (e.g., Dawson Springs area) for chemical coke production. The majority of these reserves exceed 2.0% (natural) sulfur after cleaning, but are sufficiently low in sulfur that they could be exploited as low sulfur-cleaned coal with some sacrifice in yield.

In recent years, the Illinois State Geological Survey has conducted washability studies with the support of HEW (NAPCA). Helfinstine et al (1970) concluded that only with those Illinois coals having relatively low sulfur content, as mined, could the sulfur content be reduced to 1.5% or less by washing techniques. Sheridan (1968) indicated that West Kentucky coals have a cleaned sulfur content which averages 2.0-2.5%, exceeding the acceptable low sulfur coal limits set for this study.

The National Air Pollution Control Administration is conducting studies of sulfur cleaning characteristics of coals now being produced, but data are limited. Samples from some 250 producing mines are being tested on the basis of:

1. "easily cleanable", defined as sulfur reduction to 1% or less and recovery of BTU's over 90% at a top size of 3/8 inch; and

2. "cleanable", defined as sulfur reduction to 1% or less and BTU recovery over 80% at a top size of 14 mesh.

If results were available in large quantities, a more definitive estimate of low sulfur-cleaned coal availability would be practical.

Information concerning the distribution of pyritic sulfur within coal is also difficult to obtain. The pyritic sulfur coals in the MWCF can vary from a low of 30% to a high of 80% of the total sulfur.

Where possible, statistical information was collected for cleaned coal sulfur content, based on delivered samples. These data are in part unreliable because of a lack of information concerning (1) size of coal, (2) completeness of preparation (washing), and (3) yield. Furthermore, a majority of mine-cleaning facilities are designed principally for ash removal - although some pyritic sulfur is removed with the ash. (Descriptions of cleaning facilities are included in the Keystone Coal Industry Manual.) A majority of the washed (cleaned) data, therefore, reflect mine preparation designed principally to realize high yields and ash reduction - rather than sulfur reduction. Companies involved in the preparation of coals for metallurgical coke are a notable exception, i.e., coals are cleaned for reduction of ash and sulfur.

Factors Influencing Availability

Recoverability

Recoverability reserves of low-sulfur cleaned coal in the MWCF are estimated to amount to 735 million tons, most of which are in deep seams in Illinois (Figure 5-36). Their distribution is illustrated in Figure 5-37.

Of the total 124 million tons of strippable reserves in Pike and Warrick Counties, Indiana, (Figure 5-35) all have a favorable stripping ratio suggesting "availability".¹⁴ These reserves should be regarded as near-term sources of available low-sulfur cleaned coal in contrast to the larger (1,296 million tons) deep reserve in Illinois, Indiana and West Kentucky.

A determinant of availability of deep reserves is the proximity of these reserves to current deep

14 Refer to section dealing with natural low sulfur coal for discussion of working assumptions concerning availability.

Seam	County	Total Reserves (Deep)	AVAILABLE		UNAVAILABLE (but accessible to commercial mining operations)	
			Limited steel industry interest: within or near split coal area	No current operating mine in area	Unfavorable conditions for Recovery - small and isolated blocks	Favorable conditions for Recovery - large blocks favorable to coke
2	Woodford	105	--	105	--	--
6	Clinton	34	--	34	--	--
6	Franklin	406	15	54	55	282 / <u>1</u>
6	Jackson	45	35	--	10	
6	Jefferson	665	10	50		605 / <u>1</u>
6	Madison	102	--	102 / <u>2</u>	--	--
6	Perry	78	9	50	19	--
6	St. Clair	32	--	32	--	--
6	Williamson	12	--	--	6	--
TOTALS		1473	69	427	90	887

/1 Large mines are currently operating in portions of these reserves, and supplying metallurgical coke.

/2 Gluskoter and Simon (1968) report this coal is less suitable for producing metallurgical coke than that in Franklin County area.

Figure 5-33. Estimated deep (natural) low sulfur reserves in Illinois versus indicators of availability. Table should be used independently only after careful reference to study objectives and constraints.

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S&PYR	S&ORG	S&TOT	S&CLN	% DIFF
ILL	DAVIS	GALLATIN	10S-9E	127	4.5-UP			5.0	2.7	46
ILL	DAVIS	SALINE	10S-5E	62	4.0-4.4	3.5	1.5	4.4	3.4	23
ILL	DAVIS	WILLIAMSON	10S-4E	51	4.5-UP	4.3	1.6	5.9	4.0	32
ILL	DEKOVEN	GALLATIN	10S-9E	93	4.0-4.4			4.2	2.9	31
ILL	DEKUVEN	SALINE	10S-5E	58	4.5-UP	4.3	1.6	5.2	4.6	12
ILL	DEKUVEN	WILLIAMSON	10S-4E	47	4.5-UP	4.3	1.6	5.9	4.6	22
ILL	2	ADAMS	2N-5W	83	4.5-UP			4.8	2.5	48
ILL	2	FULTON	3N-1E	72	3.5-3.9			3.8	3.1	18
ILL	2	FULTON	6N-4F	104	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	FULTON	7N-5E	97	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	FULTON	7N-6E	58	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	GRUNDY	32N-8E	77	3.0-3.4			3.3	3.2	3
ILL	2	HENRY	16N-3E	94	4.5-UP			5.4	3.6	33
ILL	2	HENRY	16N-4F	49	4.5-UP			5.4	3.6	33
ILL	2	KANKAKEE	31N-9F	34	3.0-3.4			3.2	2.6	19
ILL	2	MC DONOUGH	4N-2W	24	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	MC DONOUGH	4N-3W	80	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	PEGRIA	6N-6E	8	4.0-4.4	2.7	2.0	4.0	3.8	5
ILL	2	SCHUYLER	2N-4W	58	4.5-UP			4.8	2.5	48
ILL	2	SCHUYLER	3N-2W	91	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	SCHUYLER	3N-3W	62	4.5-UP	2.7	2.0	4.7	2.8	40
ILL	2	WILL	32N-9E	3	2.0-2.4	1.8	0.7	2.4	2.4	0
ILL	4	SALINE	10S-5E	73	4.0-4.4	2.3	1.9	4.2	3.4	19
ILL	4	WILLIAMSON	10S-4E	83	4.0-4.4	2.3	1.9	4.2	3.4	19
ILL	5	FRANKLIN	5S-1E	116	4.0-4.4			4.0	3.5	13
ILL	5	FRANKLIN	5S-2E	147	4.5-UP			4.5	3.8	16
ILL	5	FRANKLIN	6S-1E	158	3.5-3.9			3.5	3.1	11
ILL	5	FRANKLIN	6S-2E	143	3.5-3.9			3.8	3.2	16
ILL	5	FRANKLIN	6S-3E	153	4.5-UP			4.5	4.0	11
ILL	5	FULTON	3N-2E	211	4.0-4.4			4.4	4.2	5
ILL	5	FULTON	5N-1E	6	4.5-UP			5.1	4.2	18
ILL	5	FULTON	5N-4E	169	3.5-3.9	1.4	2.2	3.6	2.9	19
ILL	5	FULTON	5N-5E	51	3.5-3.9	1.4	2.2	3.6	2.9	19
ILL	5	FULTON	6N-2E	93	3.5-3.9	1.4	2.2	3.6	2.9	19
ILL	5	FULTON	6N-3E	118	3.5-3.9	1.4	2.2	3.6	3.1	14
ILL	5	FULTON	6N-4E	114	3.5-3.9	1.4	2.2	3.6	3.1	14
ILL	5	FULTON	6N-5E	14	3.5-3.9	1.4	2.2	3.6	2.9	19
ILL	5	FULTON	7N-3E	50	3.5-3.9	2.5	1.1	3.6	3.3	8
ILL	5	FULTON	8N-3E	149	3.5-3.9			3.8	3.1	18
ILL	5	GALLATIN	10S-8E	86	4.0-4.4	2.2	1.7	4.0	3.0	25

Figure 5-34. Summary of Low Sulfur Cleaned Reserves Data by Seam and Unit Area.

Table should be used independently only after careful reference to study constraints.

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S&P/R	S&O/RG	S&TOT	S&CLN	% DIFF
ILL	5		GALLATIN	10S-9E	99	4.5-UP	3.0	1.7	4.7	3.3	30
ILL	5		GALLATIN	8S-10E	106	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		GALLATIN	8S-11E	14	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		GALLATIN	8S-9E	102	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		GALLATIN	9S-10E	127	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		GALLATIN	9S-11E	15	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		GALLATIN	9S-9E	114	4.0-4.4	2.7	1.7	4.4	3.3	25
ILL	5		HAMILTON	7S-6E	91	2.5-2.9			2.5	2.0	20
ILL	5		PEORIA	7N-6E	107	3.5-3.9	1.6	1.1	3.8	2.9	24
ILL	5		PERRY	5S-1E	35	4.0-4.4			4.0	3.5	13
ILL	5		PERRY	5S-4W	37	4.5-UP			4.5	3.8	16
ILL	5		RANDOLPH	5S-6W	60	4.5-UP			4.7	4.1	13
ILL	5		SALINE	10S-7E	27	4.0-4.4			4.2	3.0	29
ILL	5		SALINE	8S-5E	118	2.0-2.4			2.4	2.1	13
ILL	5		SALINE	8S-6E	104	2.5-2.9	1.6	0.8	2.6	2.3	12
ILL	5		SALINE	8S-7E	40	2.5-2.9	1.6	0.8	2.5	2.0	20
ILL	5		SALINE	9S-5E	152	2.5-2.9	1.3	1.3	2.8	2.0	29
ILL	5		SALINE	9S-5E	75	2.5-2.9	1.9	0.8	2.5	1.9	24
ILL	5		SALINE	9S-7E	188	4.5-UP			4.8	2.9	40
ILL	5		SCHUYLER	2N-1W	95	4.0-4.4			4.0	3.6	10
ILL	5		WILLIAMSON	9S-3E	56	3.5-3.9			3.5	2.7	23
ILL	5		WILLIAMSON	9S-4E	134	2.5-2.9			2.5	2.2	12
ILL	6		BOND	7N-3W	91	4.5-UP			4.7	4.5	4
ILL	6		CHRISTIAN	11N-1E	257	4.5-UP			4.7	4.2	11
ILL	6		CHRISTIAN	12N-4W	145	4.5-UP	2.5	3.0	5.5	4.2	24
ILL	6		CHRISTIAN	13N-4W	138	4.5-UP	3.2	1.9	5.1	4.7	8
ILL	6		CLINTON	1N-1W	134	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6		CLINTON	1N-2W	141	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6		CLINTON	1N-3W	192	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6		CLINTON	1N-4W	138	4.0-4.4	2.2	2.2	4.4	3.5	20
ILL	6		CLINTON	1N-5W	245	4.0-4.4	2.2	2.2	4.4	3.5	20
ILL	6		CLINTON	1S-5W	99	4.5-UP	2.5	2.2	4.7	3.4	28
ILL	6		CLINTON	2N-1W	234	4.0-4.4	2.2	2.2	4.4	3.5	20
ILL	6		CLINTON	2N-2W	210	4.0-4.4	2.2	2.2	4.4	3.5	20
ILL	6		CLINTON	2N-3W	208	4.0-4.4	2.2	2.2	4.4	3.5	17
ILL	6		CLINTON	2N-4W	224	4.0-4.4	2.2	2.2	4.4	3.5	15
ILL	6		CLINTON	2N-5W	124	4.0-4.4	2.2	2.2	4.4	3.5	20
ILL	6		DOUGLAS	16N-10E	207	3.0-3.4			3.0	2.5	17
ILL	6		FAYETTE	8N-1E	257	4.5-UP	3.3	2.0	5.3	4.2	21

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S*PYR	S*ORG	S*TOT	S*CLN	% DIFF
ILL	6	FAYETTE	8N-1W	270	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	8N-2E	207	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	8N-3E	65	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	9N-1E	131	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	9N-1W	145	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	9N-2E	121	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FAYETTE	9N-3E	92	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	FRANKLIN	5S-1E	93	1.0-1.4	0.6	0.6	1.3	0.9	31
ILL	6	FRANKLIN	5S-2E	149	1.5-1.9	0.7	0.7	1.5	1.1	27
ILL	6	FRANKLIN	6S-1E	106	2.0-2.4			2.0	1.8	10
ILL	6	FRANKLIN	6S-2E	23	1.5-1.9			1.9	1.2	37
ILL	6	FRANKLIN	6S-3E	170	3.5-3.9	2.4	1.3	3.7	3.0	19
ILL	6	FRANKLIN	7S-1E	79	3.0-3.4			3.3	2.5	24
ILL	6	FRANKLIN	7S-2E	4	1.0-1.4	0.6	0.5	1.1	1.0	9
ILL	6	FRANKLIN	7S-3E	149	4.0-4.4	2.6	1.4	4.0	3.1	23
ILL	6	FULTON	6N-3E	2	3.5-3.9			3.7	2.9	22
ILL	6	FULTON	7N-5E	20	3.5-3.9			3.7	2.9	22
ILL	6	FULTON	8N-3E	68	3.5-3.9			3.6	2.9	19
ILL	6	FULTON	8N-4E	129	3.5-3.9			3.7	2.9	22
ILL	6	GALLATIN	10S-8E	51	4.0-4.4			4.0	3.2	20
ILL	6	GALLATIN	10S-9E	80	4.5-UP	3.3	1.6	4.9	3.1	37
ILL	6	GALLATIN	9S-8E	62	4.5-UP			4.8	2.8	42
ILL	6	HAMILTON	7S-6E	137	4.0-4.4			4.1	2.7	34
ILL	6	HENRY	17N-4E	0	3.0-3.4			3.1	2.8	10
ILL	6	JACKSON	7S-1W	81	2.5-2.9	1.8	1.4	2.7	1.8	33
ILL	6	JACKSON	7S-1W	45	1.5-1.9			1.7	1.4	18
ILL	6	JACKSON	7S-2W	18	3.5-3.9			3.5	2.9	17
ILL	6	JEFFERSON	1S-1E	179	4.0-4.4			4.4	4.1	7
ILL	6	JEFFERSON	1S-4E	160	4.0-4.4			4.4	4.1	7
ILL	6	JEFFERSON	3S-1E	65	1.5-1.9	0.9	0.5	1.5	1.3	13
ILL	6	JEFFERSON	3S-1E	213	3.0-3.4	2.2	1.2	3.4	3.1	9
ILL	6	JEFFERSON	3S-2E	142	1.5-1.9	0.9	0.5	1.5	1.3	13
ILL	6	JEFFERSON	3S-2E	142	3.0-3.4	2.2	1.2	3.4	3.1	9
ILL	6	JEFFERSON	4S-1E	145	1.5-1.9	0.8	0.7	1.5	1.2	20
ILL	6	JEFFERSON	4S-1E	98	3.0-3.4	1.9	1.4	3.3	2.6	21
ILL	6	JEFFERSON	4S-2E	250	1.5-1.9	0.9	0.7	1.6	1.2	25
ILL	6	KNOX	12N-3E	114	3.5-3.9			3.5	3.3	6
ILL	6	MACCUPIN	11N-6W	276	4.5-UP	2.3	2.7	5.0	3.8	24
ILL	6	MACCUPIN	12N-7W	187	4.0-4.4	2.2	1.8	4.0	2.3	43
ILL	6	MACCUPIN	12N-9W	168	4.0-4.4	2.2	1.8	4.0	2.3	43

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

PAGE NO. 4

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/LQUAD	RESERVES (MILLION TONS)	S-CLASS	S&PYR	S&ORG	S&TOT	S&CLN	% DIFF
ILL	6	MACOLPIN	7N-6W	39	4.5-UP			4.7	4.2	11
ILL	6	MACCUPIN	8N-7W	133	4.5-UP	2.3	2.1	4.7	4.3	9
ILL	6	MACCUPIN	8N-9W	180	4.0-4.4	2.1	1.3	4.2	2.8	33
ILL	6	MACCUPIN	9N-6W	187	2.0-2.4	1.6	0.9	2.4	1.7	29
ILL	6	MADISON	3N-7W	35	1.5-1.9	1.2	0.7	1.8	1.5	17
ILL	6	MADISON	3N-7W	139	3.0-3.4	2.1	1.1	3.4	3.0	12
ILL	6	MADISON	3N-8W	62	4.5-UP	1.5	1.7	4.7	4.4	6
ILL	6	MADISON	5N-6W	132	4.0-4.4			4.3	3.4	21
ILL	6	MADISON	6N-6W	95	4.0-4.4			4.4	3.6	18
ILL	6	MONTGOMERY	11N-4W	120	4.5-UP	2.5	3.0	5.5	4.2	24
ILL	6	MONTGOMERY	11N-5W	221	4.5-UP	2.3	2.7	5.0	4.4	12
ILL	6	MONTGOMERY	12N-4W	156	4.5-UP	3.0	2.5	5.5	4.4	20
ILL	6	MONTGOMERY	12N-5W	280	4.5-UP	3.2	2.0	5.4	4.4	19
ILL	6	MONTGOMERY	7N-3W	140	4.5-UP			4.7	4.5	4
ILL	6	MONTGOMERY	8N-3W	253	4.5-UP			4.7	4.7	0
ILL	6	MONTGOMERY	9N-1W	145	4.5-UP	3.5	2.0	5.5	4.5	18
ILL	6	MONTGOMERY	9N-5W	21	2.0-2.4	1.6	0.9	2.4	1.7	29
ILL	6	PEORIA	10N-5E	44	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	10N-6E	66	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	10N-7E	67	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	7N-6E	13	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	8N-6F	152	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	9N-7E	114	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PEORIA	9N-6E	72	4.0-4.4	2.7	1.7	4.4	3.0	25
ILL	6	PEORIA	9N-7E	75	4.0-4.4	2.7	1.7	4.4	3.0	32
ILL	6	PERRY	4S-1W	216	3.5-3.9	1.7	1.9	3.8	2.9	24
ILL	6	PERRY	4S-2W	255	4.0-4.4	2.0	2.3	4.2	3.2	24
ILL	6	PERRY	4S-3W	266	4.5-UP	2.2	2.6	4.8	3.4	29
ILL	6	PERRY	4S-4W	245	4.0-4.4	2.2	2.6	4.2	3.4	19
ILL	6	PERRY	5S-2W	199	4.5-UP	2.2	2.3	4.5	3.6	20
ILL	6	PERRY	5S-4W	236	3.5-3.9			3.8	3.5	8
ILL	6	PERRY	6S-2W	70	3.0-3.4	1.7	1.9	3.0	2.9	3
ILL	6	PERRY	6S-4W	159	4.0-4.4			4.2	2.4	43
ILL	6	RANDOLPH	4S-5W	184	4.0-4.4	2.7	2.1	4.1	3.5	15
ILL	6	RANDOLPH	4S-6W	135	4.0-4.4	2.4	2.0	4.4	3.7	16
ILL	6	RANDOLPH	4S-7W	64	4.0-4.4	2.4	2.0	4.4	3.7	16
ILL	6	RANDOLPH	5S-5W	82	4.5-UP	2.8	2.2	5.0	3.6	28
ILL	6	RANDOLPH	5S-6W	26	4.0-4.4	2.4	1.9	4.0	3.7	8
ILL	6	RANDOLPH	6S-5W	3	4.0-4.4	2.4	2.0	4.3	3.7	14
ILL	6	SALINE	9S-5E	143	3.5-3.9	2.5	1.2	3.5	2.5	29

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S\$PYR	S\$ORG	S\$TOT	S\$CLN	% DIFF
ILL	6	SALINE	9S-6E	105	3.5-3.9	2.5	1.2	3.7	2.5	32
ILL	6	SANGAMON	13N-5W	295	4.5-UP	3.4	2.0	5.4	4.4	19
ILL	6	SANGAMON	13N-6W	224	4.0-4.4	1.9	2.4	4.4	3.5	20
ILL	6	SANGAMON	14N-4W	211	4.5-UP	3.5	2.0	5.5	4.5	18
ILL	6	SANGAMON	14N-5W	255	4.5-UP	3.4	2.0	5.4	4.4	19
ILL	6	SHELBY	9N-1E	128	4.5-UP	3.3	2.0	5.3	4.2	21
ILL	6	ST CLAIR	1N-6W	225	4.5-UP	3.2	2.2	4.7	3.5	26
ILL	6	ST CLAIR	1N-7W	229	4.5-UP	3.2	2.2	4.7	3.5	26
ILL	6	ST CLAIR	1N-8W	72	4.0-4.4			4.2	3.8	10
ILL	6	ST CLAIR	1N-9W	77	4.0-4.4			4.0	3.6	10
ILL	6	ST CLAIR	1S-6W	284	4.0-4.4	2.2	2.2	4.4	3.3	25
ILL	6	ST CLAIR	1S-7W	235	4.5-UP	2.6	2.2	4.7	3.5	26
ILL	6	ST CLAIR	1S-8W	44	4.5-UP	2.7	2.5	5.3	4.0	25
ILL	6	ST CLAIR	1S-9W	155	3.5-3.9			3.8	3.5	8
ILL	6	ST CLAIR	2N-6W	123	4.5-UP	3.2	2.2	5.4	3.5	35
ILL	6	ST CLAIR	2N-7W	1	2.0-2.4	1.2	0.8	2.0	1.5	25
ILL	6	ST CLAIR	2N-7W	62	3.5-3.9	2.8	1.0	3.8	2.0	47
ILL	6	ST CLAIR	2N-8W	124	4.5-UP	2.1	2.4	4.5	4.1	9
ILL	6	ST CLAIR	2S-6W	267	4.0-4.4	2.4	2.1	4.4	3.5	20
ILL	6	ST CLAIR	2S-7W	90	4.0-4.4	2.4	2.2	4.4	3.5	20
ILL	6	ST CLAIR	3S-6W	139	4.0-4.4	2.6	2.0	4.4	3.7	16
ILL	6	ST CLAIR	3S-7W	2	4.5-UP	2.8	2.1	4.6	3.4	26
ILL	6	STARK	12N-5E	152	4.5-UP	3.4	1.5	4.9	3.0	39
ILL	6	STARK	12N-6E	3	4.5-UP	3.4	1.5	4.9	3.0	39
ILL	6	STARK	13N-6E	62	4.0-4.4	2.7	1.4	4.1	2.9	29
ILL	6	VERMILION	17N-11W	158	2.5-2.9			2.7	1.5	44
ILL	6	VERMILION	17N-12W	217	2.5-2.9			2.5	2.0	20
ILL	6	VERMILION	17N-13W	48	2.5-2.9			2.5	2.0	20
ILL	6	VERMILION	18N-12W	147	2.5-2.9	1.7	0.8	2.5	1.5	40
ILL	6	VERMILION	19N-11W	12	3.5-3.9			3.9	2.7	31
ILL	6	WASHINGTON	1N-1W	66	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	1N-2W	90	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	1N-3W	41	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	1S-1W	233	4.5-UP	2.8	2.2	5.0	3.5	30
ILL	6	WASHINGTON	1S-2W	214	4.5-UP	2.8	2.2	5.0	3.5	30
ILL	6	WASHINGTON	1S-3W	226	4.5-UP	2.8	2.2	5.0	3.5	30
ILL	6	WASHINGTON	1S-4W	265	4.5-UP	2.8	2.2	5.0	3.4	32
ILL	6	WASHINGTON	1S-5W	185	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	2S-1W	142	4.5-UP	2.8	2.2	5.0	3.5	30
ILL	6	WASHINGTON	2S-2W	124	4.5-UP	2.8	2.2	5.0	3.5	30

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

PAGE NO. 1

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S&PYR	S&ORG	S&TOT	S&CLN	% DIFF
ILL	6	WASHINGTON	2S-3W	229	4.5-UP	2.6	2.3	4.8	3.5	27
ILL	6	WASHINGTON	2S-4W	276	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	2S-5W	298	4.5-UP	2.5	2.2	4.5	3.4	24
ILL	6	WASHINGTON	3S-1W	197	4.0-4.4	2.2	2.1	4.4	3.2	27
ILL	6	WASHINGTON	3S-2W	302	4.0-4.4	2.2	2.1	4.3	3.2	26
ILL	6	WASHINGTON	3S-3W	234	4.0-4.4	2.8	2.2	4.0	3.5	13
ILL	6	WASHINGTON	3S-4W	268	4.5-UP	2.5	2.2	4.7	3.5	26
ILL	6	WASHINGTON	3S-5W	232	4.5-UP	2.8	1.9	4.7	3.6	23
ILL	6	WILLIAMSON	8S-2E	3	1.5-1.9	0.9	0.5	1.5	1.1	27
ILL	6	WILLIAMSON	8S-3E	3	1.5-1.9	1.3	0.7	1.9	1.5	21
ILL	6	WILLIAMSON	8S-3E	126	3.0-3.4	1.3	2.0	3.3	2.7	18
ILL	6	WILLIAMSON	8S-4E	237	3.0-3.4	1.8	1.4	3.0	2.6	13
ILL	6	WILLIAMSON	9S-3E	45	3.5-3.9	1.3	2.0	3.5	2.7	23
ILL	6	WILLIAMSON	9S-4F	207	3.0-3.4	1.9	1.6	3.4	3.0	12
ILL	7	VERMILION	19N-11W	54	3.0-3.4			3.4	3.1	9
ILL	7	VERMILION	19N-12W	159	3.0-3.4	1.6	1.7	3.3	3.0	9
ILL	7	VERMILION	19N-13W	233	2.5-2.9			2.9	2.6	10

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEARED

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	\$%PYR	\$%ORG	\$%TOT	\$%CLN	% DIFF
IND	CUAL	I	PIKE	3S-7W	49	4.0-4.4	2.0	2.0	4.0	3.5	13
IND	CUAL	I	WARRICK	3S-7W	28	4.0-4.4	2.2	2.0	4.2	3.7	12
IND	CUAL	III	CLAY	9N-7W	81	4.5-UP	3.9	2.5	6.4	4.1	36
IND	CUAL	III	GREENE	8N-7W	108	4.5-UP	3.9	2.5	6.4	4.1	36
IND	CUAL	III	VIGO	12N-8W	164	4.0-4.4			4.3	3.9	9
IND	CUAL	III	VIGO	13N-7W	7	4.5-UP			5.2	4.0	23
IND	COAL	III	VIGO	13N-8W	87	4.5-UP	2.7	2.8	5.5	3.4	38
IND	CUAL	III	VIGO	13N-9W	219	4.5-UP	2.8	2.9	5.7	3.5	39
IND	CUAL	IV	GREENE	7N-7W	84	1.5-1.9	1.0	0.6	1.6	1.0	37
IND	COAL	IV	GREENE	8N-7W	77	1.5-1.9			1.7	1.5	12
IND	CUAL	IV	PIKE	3S-7W	14	3.5-3.9			3.7	3.7	C
IND	CUAL	IV	SULLIVAN	7N-8W	182	1.5-1.9	1.0	0.9	1.9	1.7	11
IND	COAL	IV	VIGC	13N-9W	50	1.5-1.9	1.0	0.5	1.5	1.0	33
IND	CCAL	V	GIBSON	1S-8W	4	4.5-UP	2.4	2.1	4.5	3.5	22
IND	COAL	V	GIBSON	2S-11W	186	2.5-2.9			2.8	1.9	32
IND	CUAL	V	GIBSON	2S-8W	34	4.5-UP	2.4	2.1	4.5	3.5	22
IND	CUAL	V	GIBSON	2S-9W	192	4.5-UP	2.4	2.1	4.5	3.5	22
IND	CUAL	V	GIBSON	3S-8W	51	4.0-4.4	2.3	1.9	4.2	3.5	17
IND	CUAL	V	GIBSON	3S-9W	192	4.5-UP	2.4	2.1	4.5	3.5	22
IND	CUAL	V	GREENE	6N-7W	6	4.5-UP	2.9	2.6	5.5	3.4	38
IND	COAL	V	GREENE	7N-7W	52	4.5-UP			4.6	3.2	30
IND	CUAL	V	GREENE	8N-7W	31	4.5-UP	2.9	2.6	5.5	3.9	29
IND	CUAL	V	KNUX	4N-8W	40	2.5-2.9	1.9	1.9	2.8	2.4	14
IND	CUAL	V	KNCX	5N-7W	1	4.5-UP	2.3	2.7	5.0	3.2	36
IND	CUAL	V	KNCX	5N-8W	114	4.5-UP	2.3	2.7	5.0	3.2	36
IND	CUAL	V	PIKE	1N-7W	6	1.5-1.9			1.9	1.7	11
IND	COAL	V	PIKE	1S-7W	63	1.5-1.9			1.8	1.4	22
IND	CUAL	V	PIKE	1S-8W	146	4.5-UP	2.1	2.5	4.6	3.5	24
IND	COAL	V	PIKE	1S-9W	85	2.0-2.4			2.0	2.0	0
IND	CUAL	V	PIKE	2S-7W	4	3.5-3.9	1.9	1.9	3.8	3.7	3
IND	CUAL	V	PIKE	2S-8W	12	4.5-UP	2.1	2.5	4.6	3.5	24
IND	CUAL	V	PIKE	3S-8W	41	4.5-UP	2.1	2.5	4.6	3.5	24
IND	COAL	V	SULLIVAN	6N-8W	176	4.0-4.4	2.2	1.9	4.1	3.0	27
IND	COAL	V	SULLIVAN	6N-9W	137	4.5-UP	2.5	2.2	4.6	3.2	30
IND	CUAL	V	SULLIVAN	7N-8W	207	3.5-3.9	2.2	1.8	3.9	2.8	28
IND	COAL	V	SULLIVAN	7N-9W	190	4.5-UP	2.5	2.2	4.6	3.2	30
IND	CUAL	V	SULLIVAN	8N-8W	88	3.5-3.9			3.5	2.5	29
IND	CUAL	V	VIGO	10N-8W	88	4.0-4.4	1.4	2.8	4.2	3.0	29
IND	COAL	V	VIGO	10N-9W	172	3.0-3.4	1.6	1.6	3.3	3.2	3
IND	COAL	V	VIGO	11N-8W	33	4.0-4.4	1.9	2.3	4.2	3.0	29

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVEFS (MILLION TONS)	S-CLASS	\$PYR	\$ORG	\$TOT	\$CLN	% DIFF
IND	COAL	V	VIGO	11N-9W	112	4.0-4.4			4.0	3.5	13
IND	COAL	V	VIGO	13N-9W	47	4.5-UP			4.5	3.6	20
IND	COAL	V	WARRICK	3S-7W	28	4.5-UP	2.5	2.4	4.9	3.6	27
IND	COAL	V	WARRICK	3S-8W	48	4.5-UP	2.5	2.2	4.7	3.6	23
IND	COAL	V	WARRICK	4S-7W	168	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	V	WARRICK	4S-8W	149	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	V	WARRICK	4S-9W	166	4.5-UP	2.4	2.3	4.7	3.3	30
IND	COAL	V	WARRICK	5S-8W	147	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	V	WARRICK	5S-9W	185	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	V	WARRICK	6S-8W	62	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	VI	GIBSON	2S-8W	8	4.0-4.4	2.3	1.8	4.1	2.8	32
IND	COAL	VI	GIBSON	3S-8W	27	3.0-3.4	1.6	1.4	3.0	2.5	17
IND	COAL	VI	GIBSON	3S-9W	128	4.0-4.4	2.3	1.9	4.2	2.9	31
IND	COAL	VI	GREENE	8N-7W	0	2.0-2.4			2.4	2.3	4
IND	COAL	VI	KNOX	5N-8W	128	4.0-4.4			4.1	2.8	32
IND	COAL	VI	PIKE	1S-8W	64	2.0-2.4	1.0	1.0	2.0	1.9	5
IND	COAL	VI	PIKE	3S-8W	25	2.0-2.4	1.0	1.0	2.0	1.7	15
IND	COAL	VI	SULLIVAN	6N-8W	137	4.0-4.4	2.4	1.6	4.0	2.8	30
IND	COAL	VI	SULLIVAN	7N-8W	186	4.0-4.4	2.4	1.6	4.0	2.8	30
IND	COAL	VI	SULLIVAN	7N-9W	191	4.0-4.4	2.9	1.4	4.4	2.9	34
IND	COAL	VI	SULLIVAN	8N-8W	63	2.5-2.9	1.5	1.0	2.6	2.1	19
IND	COAL	VI	SULLIVAN	9N-8W	11	4.0-4.4	2.9	1.4	4.3	2.9	33
IND	COAL	VI	SULLIVAN	9N-9W	162	4.0-4.4	2.9	1.4	4.4	2.9	34
IND	COAL	VI	VERMILLION	14N-10W	105	3.0-3.4	1.7	1.3	3.0	2.4	20
IND	COAL	VI	VERMILLION	14N-9W	56	3.5-3.9	2.2	1.7	3.9	2.6	33
IND	COAL	VI	VIGO	12N-10W	118	3.5-3.9	2.2	1.7	3.9	2.6	33
IND	COAL	VI	VIGO	12N-9W	169	3.5-3.9	2.2	1.7	3.9	2.6	33
IND	COAL	VI	VIGO	13N-10W	159	3.5-3.9	2.2	1.7	3.9	2.6	33
IND	COAL	VI	VIGO	13N-9W	52	3.5-3.9	2.2	1.7	3.9	2.6	33
IND	COAL	VI	WARRICK	3S-7W	35	2.0-2.4	1.0	1.0	2.0	1.9	5
IND	COAL	VI	WARRICK	4S-8W	93	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	VI	WARRICK	4S-9W	148	4.5-UP	2.4	2.3	4.7	3.3	30
IND	COAL	VI	WARRICK	5S-9W	109	4.5-UP	2.4	2.3	4.7	3.2	32
IND	COAL	VII	GREENE	8N-7W	0	1.0-1.4	0.6	0.6	1.2	1.1	8
IND	COAL	VII	PIKE	1S-8W	52	1.5-1.9	0.9	0.8	1.7	1.5	12
IND	COAL	VII	PIKE	2S-8W	62	4.0-4.4	2.3	1.9	4.2	2.9	31
IND	COAL	VII	PIKE	2S-9W	127	4.0-4.4	2.3	1.9	4.2	2.9	31
IND	COAL	VII	PIKE	3S-8W	29	4.0-4.4	2.3	1.9	4.2	2.9	31
IND	COAL	VII	SULLIVAN	6N-8W	34	1.5-1.9	0.9	0.7	1.6	1.3	19
IND	COAL	VII	SULLIVAN	6N-8W	67	3.5-3.9	2.2	1.8	3.9	2.8	28

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

STATE	SEAM NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	S%PYR	S%ORG	S%TOT	S%CLN	% DIFF
IND	CUAL VII	SULLIVAN	7N-8W	123	2.5-2.9	1.4	1.5	2.9	2.5	14
IND	CUAL VII	SULLIVAN	8N-8W	9	3.5-3.9			3.6	3.3	8
IND	CUAL VII	SULLIVAN	8N-8W	19	1.0-1.4			1.0	0.6	40
IND	CUAL VII	SULLIVAN	9N-8W	21	1.5-1.9	0.7	1.9	1.6	1.3	19
IND	CUAL VII	VIGO	10N-8W	25	1.5-1.9	0.6	1.3	1.9	1.3	32
IND	CUAL VII	VIGO	10N-9W	123	1.5-1.9	0.7	0.9	1.7	1.2	29
IND	MINSHALL	GREENE	7N-7W	0	3.0-3.4			3.4	3.1	9
IND	MINSHALL	SULLIVAN	6N-8W	83	4.5-UP	2.2	2.3	5.5	3.3	40
IND	UPPER BLOCK	CLAY	12N-6W	61	4.5-UP			5.6	2.4	57
IND	UPPER BLOCK	GREENE	8N-6W	49	1.5-1.9	0.7	0.8	1.5	1.4	7
IND	UPPER BLOCK	CHEN	9N-6W	10	1.5-1.9	0.7	0.8	1.5	1.4	7

REPORT OF PERCENTAGE DIFFERENCE OF SULFUR CLEANED

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STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	\$PYR	\$GRG	\$TOT	\$CLN	% DIFF
WY	11		HOPKINS	16	30	3.5-3.9			3.9	3.5	10
WY	11		HOPKINS	17	32	4.0-4.4			4.1	3.4	17
WY	11		HOPKINS	18	22	4.5-UP			4.6	4.0	13
WY	11		HOPKINS	29	31	3.5-3.9			3.9	3.5	10
WY	11		HOPKINS	30	139	3.5-3.9			3.6	3.2	11
WY	11		HOPKINS	31	43	3.5-3.9			3.5	3.2	9
WY	11		HOPKINS	32	29	3.5-3.9			3.5	3.3	6
WY	11		HOPKINS	47	11	4.0-4.4			4.0	3.5	13
WY	11		MUHLBERG	18	35	4.5-UP	1.9	3.2	5.1	3.3	35
WY	11		MUHLBERG	19	31	4.5-UP	1.9	3.2	5.0	3.3	34
WY	11		MUHLBERG	20	20	4.0-4.4	1.9	2.2	4.1	3.3	20
WY	11		MUHLBERG	32	71	4.0-4.4	2.0	2.8	4.0	3.1	23
WY	11		MUHLBERG	33	184	4.0-4.4	1.9	2.1	4.3	3.3	23
WY	11		MUHLBERG	34	144	4.5-UP	2.0	3.2	5.1	3.3	35
WY	11		CHIO	35	143	4.5-UP	2.3	2.5	4.7	3.8	19
WY	11		CHIO	36	41	4.5-UP	2.9	2.5	5.4	4.6	15
WY	11		CHIO	53	53	4.5-UP	2.0	2.7	4.7	3.9	17
WY	11		WEBSTER	46	28	3.5-3.9	2.0	1.6	3.7	3.1	16
WY	12		HOPKINS	17	30	3.5-3.9			3.8	3.3	13
WY	12		HOPKINS	29	61	3.5-3.9			3.6	3.1	14
WY	12		HOPKINS	30	71	3.0-3.4			3.1	3.0	3
WY	12		MUHLBERG	18	18	3.5-3.9	1.8	1.7	3.5	3.2	9
WY	12		MUHLBERG	19	10	3.5-3.9	1.8	1.7	3.5	3.2	9
WY	12		MUHLBERG	20	33	3.5-3.9	1.8	1.8	3.5	2.9	17
WY	12		MUHLBERG	32	102	3.5-3.9	1.8	1.7	3.6	3.2	11
WY	12		MUHLBERG	33	189	3.5-3.9	1.8	1.7	3.5	3.2	9
WY	13		MUHLBERG	34	161	3.5-3.9	1.8	1.8	3.5	3.0	14
WY	13		CHIO	35	38	1.5-1.9	0.8	1.0	1.8	1.6	11
WY	13		CHIO	36	23	1.5-1.9	0.8	1.0	1.8	1.6	11
WY	14		HOPKINS	30	54	4.5-UP			4.5	4.0	11
WY	14		HOPKINS	48	52	4.5-UP			4.5	3.2	29
WY	14		MUHLBERG	33	18	4.5-UP	2.9	1.8	4.7	3.1	34
WY	14		MUHLBERG	34	7	4.5-UP	2.9	1.8	4.7	3.1	34
WY	14		MUHLBERG	51	17	4.5-UP	2.9	1.8	4.7	3.1	34
WY	14		MUHLBERG	52	8	4.5-UP	2.9	1.8	4.7	3.1	34
WY	14		CHIO	35	127	4.5-UP	4.3	2.1	6.4	4.6	28
WY	14		CHIO	52	47	4.5-UP	4.3	2.0	6.3	5.2	17
WY	14		CHIO	53	41	4.5-UP	4.3	2.0	6.3	5.3	16
WY	14		WEBSTER	46	81	4.0-4.4	2.6	1.4	4.0	2.9	28
WY	4		HOPKINS	15	80	2.5-2.9			2.8	2.2	21

STATE	SEAM	NAME/NUMBER	COUNTY	TWSP/QUAD	RESERVES (MILLION TONS)	S-CLASS	\$%PYR	\$%ORG	\$%TOT	\$%CLN	% DIFF
WKY	4		HOPKINS	16	116	2.0-2.4			2.4	1.9	21
WKY	4		HOPKINS	17	97	3.5-3.9			3.5	2.7	23
WKY	4		HOPKINS	18	12	3.5-3.9			3.5	2.6	26
WKY	6		OHIO	36	20	4.5-UP	3.4	1.9	5.2	3.1	40
WKY	6		OHIO	53	20	4.5-UP	3.4	1.9	5.2	3.1	40
WKY	6		OHIO	54	27	4.5-UP	3.3	1.6	4.9	3.0	39
WKY	7		HOPKINS	30	0	4.5-UP	6.6	2.4	9.0	4.9	46
WKY	8		HOPKINS	30	68	4.5-UP	5.7	2.0	7.7	3.2	58
WKY	9		HENDERSON	76	16	4.5-UP	3.1	1.6	4.7	2.9	38
WKY	9		HENDERSON	77	244	4.5-UP	3.1	1.6	4.7	2.9	38
WKY	9		HENDERSON	78	169	4.5-UP	3.1	1.6	4.7	2.9	38
WKY	9		HENDERSON	87	220	4.5-UP	3.1	1.6	4.7	2.9	38
WKY	9		HENDERSON	88	201	4.5-UP	3.1	1.6	4.6	2.9	37
WKY	9		HOPKINS	17	3	4.0-4.4	2.0	2.1	4.0	3.2	20
WKY	9		HOPKINS	18	10	4.0-4.4	2.0	2.1	4.2	4.0	5
WKY	9		HOPKINS	29	54	4.0-4.4			4.2	3.5	17
WKY	9		HOPKINS	30	137	4.0-4.4			4.3	3.4	21
WKY	9		HOPKINS	31	158	4.0-4.4	2.0	2.1	4.1	3.3	20
WKY	9		HOPKINS	48	257	4.5-UP			4.5	4.0	11
WKY	9		MC LEAN	51	157	4.5-UP	3.1	1.6	4.7	3.3	30
WKY	9		MC LEAN	52	20	4.5-UP	3.1	1.6	4.7	3.3	30
WKY	9		MC LEAN	68	136	4.5-UP	3.5	1.4	4.9	3.0	39
WKY	9		MC LEAN	69	54	4.5-UP	3.5	1.4	4.9	3.0	39
WKY	9		MUHLenberg	18	46	4.0-4.4	2.9	1.1	4.0	3.5	13
WKY	9		MUHLenberg	19	3	4.0-4.4	3.0	1.2	4.2	3.5	17
WKY	9		MUHLenberg	20	31	4.0-4.4	2.9	1.1	4.1	3.5	15
WKY	9		MUHLenberg	21	38	4.0-4.4	1.8	2.4	4.1	3.5	15
WKY	9		MUHLenberg	32	114	4.0-4.4	3.0	1.2	4.0	3.5	13
WKY	9		MUHLenberg	33	242	4.0-4.4	2.8	1.2	4.0	3.3	18
WKY	9		MUHLenberg	34	141	3.5-3.9	2.6	1.3	3.9	3.3	15
WKY	9		MUHLenberg	51	52	4.5-UP	3.0	1.5	4.5	3.2	29
WKY	9		MUHLenberg	52	21	4.0-4.4	2.9	1.5	4.4	3.2	27
WKY	9		OHIO	34	47	4.5-UP	3.1	1.6	4.6	3.3	28
WKY	9		OHIO	35	114	4.0-4.4	2.7	1.6	4.2	3.5	17
WKY	9		OHIO	36	75	3.5-3.9	2.2	1.6	3.8	3.5	8
WKY	9		OHIO	52	184	4.5-UP	3.1	1.7	4.8	3.5	27
WKY	9		OHIO	53	52	3.5-3.9	2.2	1.6	3.9	3.5	10
WKY	9		UNION	61	73	4.0-4.4	2.5	1.6	4.0	2.5	38
WKY	9		UNION	62	132	4.5-UP	3.0	1.7	4.6	2.9	37
WKY	9		UNION	74	217	4.0-4.4	2.7	1.6	4.2	2.9	31
WKY	9		UNION	75	180	3.5-3.9	2.6	1.3	3.9	2.9	26

State	Seam	County	Unit Area	Strippable Reserves	Deep Reserves
Illinois	5	Saline	9S-6E	-	75
"	6	Franklin	6S-1E	-	106
"	6	Jackson	7S-1W	-	81
"	6	Macoupin	9N-6W	-	187
"	6	Montgomery	9N-5W	-	21
"	6	St. Clair	2N-7W	-	219
"	6	Vermilion	17N-11W	-	158
"	6	Vermilion	18N-12W	-	147
Total State of Illinois					994
Indiana	V	Gibson	25-11W	-	186
"	VI	Pike	1S-8W	64 (64)	-
"	VI	Pike	3S-8W	25 (25)	-
"	VI	Warrick	3S-7W	35 (35)	-
Total State of Indiana				124	186
West Kentucky	4	Hopkins	16	-	116
Total West Kentucky					116
Total All States				124	1296

Figure 5-35 Summary of remaining low sulfur-cleaned reserves by seam, county and unit area (millions of tons)

(•) indicates favorable stripping ratio (25:1 or better)

Reserves by seam and county	Pyritic Sulfur	Organic Sulfur	Total Sulfur	Cleaned Sulfur	% Difference (Total/Cleaned)	Thickness of Overburden
75	1.9	0.8	2.5	1.9	24	220
106	-	-	2.0	1.8	10	680
81	1.8	1.4	2.7	1.8	33	150
187	1.6	0.9	2.4	1.7	29	365
21	1.6	0.9	2.4	1.7	29	450
219	1.2	0.8	2.0	1.5	25	200
305	-	-	2.7	1.5	44	160
	1.7	1.8	2.5	1.5	40	210
994	-	-	-	-	-	
186	-	-	2.8	1.9	32	425
89	1.0	1.0	2.0	1.9	05	29 •
	1.0	1.0	2.0	1.7	15	30 •
35	1.0	1.0	2.0	1.9	05	50 •
310	-	-	-	-	-	
116	-	-	2.4	1.9	21	250
116	-	-	-	-	-	
1420	-	-	-	-	-	

Table should be used independently only after careful reference to study constraints.

States	Total Low Sulfur Reserves	Total Strip	Total Deep	Recoverable Strip	Recoverable Deep	Total Recoverable
Illinois	994	--	994	--	497	497
Indiana	310	124	186	87	93	180
West Kentucky	116	--	116	--	58	58
Total, all States	1420	124	1296	87	648	735

Figure 5-36. Summary of Low Sulfur-Cleaned Coal Recoverability by State.

Independent use of this table should include careful reference to study objectives and constraints.

mining operations (Figure 5-37). It should however, be noted that additional time will be required to build a suitable on-site cleaning facility.

A controlling time factor results from the lack of proximity of the deep reserves to current deep mining operations, and it is concluded that this low sulfur-cleaned reserves would not be available for near-term use. A total of 87 million tons of cleanable Coal V strip coal in Indiana are not only accessible for current operations, but have a favorable stripping ratio to encourage their exploitation.

In addition, little of the low-sulfur cleaned coals identified in Indiana would be reserved for use as coking coals, for they are probably of marginal coking quality and will not be exploited until reserves elsewhere with a lower sulfur content are exhausted.

5.4.3 Dedicated Coal Reserves

Dedicated low sulfur coal is that portion of producer-owner reserves that is already committed (often under long-term contract) to a specific customer. For purposes of this analysis, consideration of dedication will be limited to producing seams or those in which production is shortly anticipated.

Analyses of dedicated reserves is constrained largely by incomplete data. However, with the limited data from the producers and the Mid-West Coal Producers Institute (1966), it was possible to approximate reserves already acquired by producers, and dedicated to particular customers or uses (Figure 5-38).

Of the nearly 3,000 million tons (in-place) of low sulfur reserves (natural and cleaned) in producing seams, approximately 750 million tons (or 25%) can be reasonably identified as dedicated by producers¹⁵; and of these about 50% or 375 tons are believed recoverable¹⁶. This estimate included reserves dedicated to utilities, coke and steel, retail and other uses.

Of the total dedicated low sulfur reserves, at least 131 million tons (slightly less than 20%) are dedicated to use by utilities. This dedication of reserves implies a use that would aid pollution control; but at the same time, would insure that the reserves would not be available for that use in other industries.

In addition to the reserves shown above (and in Figure 5-39) associated with producing seams, the degree to which the remainder of the reserves in place are committed to specific uses can be considered. Some reserves not currently being mined are probably dedicated.

The greatest difficulty in assessing low sulfur reserves availability is encountered in estimating the reserves committed to specific users and particularly to the coke and steel industries. These reserves would have only limited availability for air pollution uses. Utilities and other industries would be required to bid against the steel industry for their use. To complicate the problem, the *Wall Street Journal* indicates that foreign steel companies are

starting to bid aggressively for U. S. low sulfur coal.

In the absence of complete data for assessing low sulfur coals dedicated to manufacture of metallurgical coke, it was assumed that all coals (whether associated with a producing seam or not) of a quality¹⁷ even remotely suitable for metallurgical processing were already dedicated by producers to the coke and steel market to meet anticipated future demands.

Criteria for categorizing coking coals are identified in Figure 5-40.

As a bounding condition, the assumption was made that dedication by large commercial producers of coking coal would be limited to large blocks (at least 100 million tons) of coal in place. To justify commitment of equipment and to amortize total investment, lesser amounts might, therefore, be available for air pollution control purposes. Assuming all coals of even remote coking quality (approximately 3,000 million tons in place) were dedicated to coke and steel, the remaining coal would be available for air pollution control; recoverable reserves¹⁸ over the MWCF would amount to 2,405 million tons (Figure 5-41).

An additional and highly speculative consideration in low sulfur coal availability is the extent to which low sulfur reserves are owned by oil companies and dedicated to future hydrogenation-gasification, or have chemical characteristics, including low sulfur, which may be favorable to low cost hydrogenation.

Corcoran (1968) suggested a great market potential for liquefaction and gasification of coal. He alluded to probable oil company investment in large blocks of coal and indicated:

"Despite certain advantages of coal over other synthetic fuel sources, there are major obstacles....including the need for tremendous volumes of coal at a single plant. Site selection for a commercial-size liquefaction plant will be determined primarily by availability of large uncommitted coal reserves and also by coal quality...."

Very little information has been disclosed regarding the extent to which dedication to hydrogenation limits future low-sulfur reserves availability; the extent to which the petroleum industry control interests in reserves over the MWCF is reflected by the fact that many large coal companies are now subsidiaries of oil companies.

Under these circumstances, undedicated reserves, regardless of sulfur content, could be withheld for future hydrogenation or gasification programs. Whether low-sulfur reserves owned directly or indirectly by oil companies (and not dedicated to metallurgical coke) will be made available for air pollution control purposes, will undoubtedly be a function of market price and demands of competing users.

15 This figure includes dedicated reserves reported by producers participating in this study (353 million tons) and dedicated reserves estimated for non-participating producers (379 million tons).

16 Because dedicated coal is incomplete, a general 50% recoverability factor was used.

17 Where limited data was available, the categorizing of coking coals was based on location, i.e., if reserves occurred in a "coking-coal area" a seam largely dedicated to coke/steel production.

18 Assuming 70% for strip and 30% for deep coal



Figure 5-37. Distribution of Low Sulfur - Cleaned Coal. (See Fig. 5-30.

Independent use of this map should include careful reference to study objectives and constraints.

Seam	County	Total Reserves (Deep)	AVAILABLE		UNAVAILABLE (but accessible to commercial mining operations)
			Limited Steel Industry Interest: within or near split coal area	No current operating mine in area	
5	Saline	75	--	70	5
6	Franklin	106	106 ¹	--	--
6	Jackson	81	--	81	--
6	Macoupin	187	2	185	--
6	Montgomery	21	21	--	--
6	St. Clair	219	--	219 ²	--
6	Vermillion	305	--	305	--
TOTALS		994	129	860	5

Figure 5-37A. Estimated deep low sulfur-cleaned reserves in Illinois versus indicators of availability. Table should be used independently only after careful reference to study objectives and constraints.

¹ Not presently being mined.

² Gluskoter and Simon (1968) indicate coal is not as suitable for coke as in Franklin County area.

Figure 5-38. Dedicated and Undedicated Low Sulfur (1.1 - 2.0%) Coal Summary for Producing Seams in the MWCF.

(-) None or No Information. Not all columns will add due to independent rounding. (See attached footnotes)

State	Pro- ducing Seam	County	Low Sulfur Res.	Low Sul. Cleaned	Tot. Low Sul. Res.	Tot. Res. Owned by Partic. Prod.	Coal (1.1 - 1.9%		Known Dedicated Reserves	Prob. held		Tot. Res
							Utilities 2/ Steel	Dedicated to Other Indus. and Retail		non-partic. Erod. & Dedicated 3/	by Pro- ducers 4/ Undedicated Coal 5/ 6/	
Illinois	5	Saline	Neg.	75	75	14	3	8	14	61	75	-
Illinois	6	Franklin	406	106	512	056	-	56	56	65	121	391
Illinois	6	Jefferson	665	-	665	161	36	111	161	78	239	426
Illinois	6	Vermilion	-	305	305	55	Neg.	Neg.	1	-	1	54
Illinois	6	Williamson	12	-	12 (60) 1/	47	8	2	10	-	21	26
Illinois	6	Jackson	45	81	126	-	-	-	-	126	126	-
Total State of Illinois ----- 1128 567 1695 333 47 170 24 242 330 583 897												
Indiana	IV	Clay	6	-	6	<1	(<1)	(<1)	-	-	<1	4
Indiana	IV	Greene	273	-	273	<1	(<1)	(<1)	-	-	2	271
Indiana	V	Gibson	-	186	186	8	47	1	8	-	8	182
Indiana	V	Pike	69	-	69	29	(23)	(4)	(29)	-	29	40
Indiana	VI	Gibson	No sulfur data available - No reserves identified	-	Neg.	<1	-	-	Neg.	-	-	Neg.
Indiana	VI	Pike	-	89	89	<1	Neg.	Neg.	<1	-	<1	88
Indiana	VI	Warrick	-	35	35	<1	Neg.	Neg.	<1	-	<1	34
Indiana	VII	Pike	52	-	52	8	(7)	(1)	(8)	-	8	44
Indiana	VII	Sullivan	74	-	74	21	(18)	(3)	(21)	16	37	37
Indiana	VII	Vigo	148	-	148	16	(13)	(3)	(16)	-	16	132
Indiana	Upper Block	Clay	62	-	62	<1	Neg.	Neg.	<1	-	<1	62
Indiana	Upper Block	Greene	57	-	57	<1	Neg.	Neg.	<1	-	<1	56
Indiana	Upper Block	Owen	14	-	14	<1	Neg.	Neg.	<1	-	<1	13
Total State of Indiana ----- 755 310 1065 87 74 - 13 87 16 103 962												

Table should be used independently only after referencing study objectives and constraints.

(Continued on Page 2)

Figure 5-38. Dedicated and Undedicated Low Sulfur (1.1 - 2.0%) Coal Summary for Producing Seams in the MWCF.

(-) None or No Information. Not all columns will add due to independent rounding. (See attached footnotes)

State	Pro- ducing Scam	County	Low Sulfur Res.	Low Sul. Res. Cleaned	Tot. Low Sul. Res.	Tot. Res. Owned by Partic. Prod.	Coal (1.1 - 1.9% Utilities Coke/ 2/ Steel			Dedicated to Other Indus. and Retail	Known Dedicated Reserves	Prob. held non-partic. Prod. & Dedicated 3/		Tot. Res. Dedicated by Pro- ducers 4/	Undedicated Coal 5/
							2/	Steel				Dedicated			
West Kentucky	6	Hopkins	-	(116)	116	10	-	5	5	10	(10)	20	96		
	6	Muhlenberg	(20)	-	(20) 7/	40	(10)	-	-	10	30	40	-		
	13	Ohio	(30)	-	(30)	4	-	-	-	4	-	4	26		
	14 (top)	Ohio	Some 2.0% sulfur coal - no reserves identified	-	Neg.	3	-	-	-	-	3	3	-		
Total West Kentucky -----			50	116	166	57	10	5	5	24	33	67	122		
TOTAL ALL STATES-----			1933	993	2926	477	131	175	42	353	379	753	1981		

- 1/ Value computed does not take into account areas outside the boundary mapped by Gluskoter and Simon (1968). Greater low sulfur reserves are indicated by producers.
- 2/ Coal burned for power generation at steel plants included under coke and steel.
- 3/ As extrapolated from open sources, including testimony by Mid-West Coal Producers Institute, 1966. Includes coal probably held by non-participating producers.
- 4/ For producing seams only; where a difference between total low sulfur reserves and total reserves dedicated by producers is noted, near-term availability for air pollution control purposes is assumed.
- 5/ For producing seams only; presumed future availability for air pollution control purposes, and not now dedicated by producers.
- 6/ Includes coal which is probably held and dedicated by producers.
- 7/ Producer reported reserves exceed those estimated to be in place. Lack of low sulfur coal data did not permit higher estimates using resources data bank.

Tot. -- Total Indus. -- Industry
 Sul. Res. -- Sulfur Reserves Prob. -- Probably
 Partic. Prod. -- Participating Producers non-partic. -- non-participating

(FIGURE 3-39) Evaluation of Low Sulfur Coals Probably of Possible ^{1/} Coking Coal Quality, By Strip and Deep Categories. Table should be used independently only after reference to text description of study objectives and constraints.

STATE	SEAM	COUNTY	PROPERTIES								
			STRIP- PROBABLE COKING	STRIP-OTHER (INCLUDING LATENT COKING RESERVES)	DEEP PROBABLE COKING COAL	DEEP-OTHER (INCLUDING LATENT COKING RESERVES)	TOTAL RESERVES SEAM AND COUNTY	SULFUR (0/0)	ASH (0/0)	FREE SWELLING INDEX	
		JACKSON	-	92	-	-	-	92	1.40	08	-
	6	CLINTON	-	-	-	34	34	1.5	12	12	3.0
	6	FRANKLIN	-	-	329	77	406	1.1-1.9	12	12	4.0
	6	JACKSON	-	-	-	45	45	1.7	11	11	4.0
	6	JEFFERSON	-	-	665	-	665	1.5-1.6	09	09	5.0
	6	MADISON	-	-	-	102	102	1.1-1.8	11	11	4.0
	6	PERRY	-	17	-	78	95	1.1-1.5	11	11	1.0
	6	ST. CLAIR	-	-	-	32	32	1.5	12	12	4.0
	6	WILLIAMSON	-	6	-	6	12	0.6-1.9	14	14	5.5
TOTAL STATE OF ILLINOIS ^{2/}			-	115	1099	374	2024				

1/ Includes latent coking coal reserves

2/ Reserves in Knox, Will and Woodward counties, amounting to nearly 150 million tons, might fall into latent coking coal category, but have been eliminated based on recommendation of Illinois State Geological Survey.

(F IGURE 5-39)

Evaluation of Low Sulfur Coals Probably of Possible Coking Coal Quality, By Strip and Deep Categories (Cont.)

STATE	SEAM	COUNTY	STRIP- PROBABLE COKING	STRIP- OTHER (INCLUDING LATENT COKING RESERVES)	DEEP PROBABLE COKING COAL	DEEP-OTHER (INCLUDING LATENT COKING RESERVES)	TOTAL RESERVES SEAM AND COUNTY	SULFUR (0/0)	ASH (0/0)	FREE SWELLING INDEX
INDIANA	BLUE CREEK	DUBOIS	-	21	-	-	21	1.4	-	-
	BLUE CREEK	MARTIN	-	12	-	-	12	0.8-1.0	04	-
	BRAZIL-U	CLAY	-	123	-	-	123	1.7	-	-
	COAL I	PERRY	-	42	-	-	42	0.9	08	-
	COAL I A	MARTIAN	-	1	-	-	1	1.0	05	-
	COAL III	SULLIVAN	-	-	-	83	83	0.6	07	5.5
	COAL IV	CLAY	-	6	-	-	6	1.0	10	-
	COAL IV	DREENE	112	161	-	-	273	1.1-1.7	11	-
	COAL IV	KNOX	-	-	124	-	124	1.0	08	-
	COAL IV	SULLIVAN	-	-	100	82	182	1.9	0.9	4.5
	COAL IV	VERMILLION	-	-	-	93	93	1.1	10	-
	COAL IV	VIGO	-	-	110	50	160	1.0-1.5	09	5.5
	COAL IV A	POSEY	-	-	-	66	66	0.8	16	-
	COAL V	KNOX	-	-	121	-	121	1.1	10	5.0
	COAL V	PIKE	-	69	-	-	69	1.8-1.9	10	4.5
	COAL V	SULLIVAN	122	-	191	88	401	0.8-1.9	10	4.5
	COAL V	WARRICK	-	8	-	-	8	1.8	11	4.5
	COAL VI	GREENE	-	2	-	-	2	1.9	10	-
	COAL VI	KNOX	-	92	-	-	92	1.3	11	4.5
	COAL VI	POSEY	-	-	-	83	83	0.8	24	-
	COAL VI	SULLIVAN	-	-	154	-	154	1.3	10	3.5
	COAL VII	GREENE	-	2	-	-	2	1.6	10	4.0
	COAL VII	KNOX	-	253	-	-	253	0.7-1.5	20	-

(FIGURE 5-39)

Evaluation of Low Sulfur Coals Probably of Possible Coking Coal Quality, By Strip and Deep Categories (Cont.)

STATE	SEAM	COUNTY	PROPERTIES							
			STRIP— PROBABLE COKING	STRIP—OTHER (INCLUDING LATENT COKING RESERVES)	DEEP PROBABLE COKING COAL	DEEP—OTHER (INCLUDING LATENT COKING RESERVES)	TOTAL RESERVES SEAM AND COUNTY	SULFUR (0/0)	ASH (0/0)	FREE SWELLING INDEX
INDIANA	COAL VII	PIKE	—	52	—	5	52	1.7	10	—
	COAL VII	POSEY	—	—	—	62	62	0.9	10	—
	COAL VII	SULLIVAN	—	74	158	80	312	0.9—1.6	11	4.0
	COAL VII	VIGO	123	25	—	—	148	1.7—1.9	10	3.0
	FAIRBANKS	SULLIVAN	—	100	—	—	100	0.7	27	—
	LOWER BLOCK	GREENE	—	104	—	—	104	0.8	11	—
	LOWER BLOCK	OWEN	—	31	—	—	31	0.8—1.1	08	—
	LOWER BLOCK	PARKE	—	116	—	39	155	1.0—1.2	15	—
	LOWER BLOCK	SPENCER	—	76	—	—	76	0.7	13	—
	MANSFIELD	DAVIESS	—	86	—	—	86	0.7	—	—
	MANSFIELD	DUBOIS	—	22	—	—	22	0.5—1.7	14	—
	MARIAH HALL	DAVIESS	—	104	—	—	104	1.3	13	—
	MARIAH HALL	SPENCER	117	218	—	147	482	1.0—1.9	11	—
	MINSHALL	CLAY	—	2	—	—	2	1.2	—	—
	MINSHALL	FOUNTAIN	137	73	—	—	210	1.6—1.9	10	—
	MINSHALL	MARTIN	—	5	—	—	5	1.0	—	—
	MINSHALL	PARKE	—	19	—	—	19	1.1	14	—
	MINSHALL	SPENCER	—	6	—	—	6	1.3	08	—
	UPPER BLOCK	CLAY	—	62	—	—	62	1.2—1.9	06	1.0
	UPPER BLOCK	GREENE	—	57	—	—	57	0.6—1.5	07	—
	UPPER BLOCK	OWEN	—	14	—	—	14	1.5	08	—
	UPPER BLOCK	PARKE	—	—	—	100	38	1.0	15	—
TOTAL STATE OF INDIANA			611	2038	1058	911	4618			

(FIGURE 9-39)

Evaluation of Low Sulfur Coals Probably of Possible Coking Coal Quality, By Strip and Deep Categories (Cont.)

STATE	SEAM	COUNTY	PROPERTIES							
			STRIP- PROBABLE COKING	STRIP-OTHER (INCLUDING LATENT COKING RESERVES)	DEEP PROBABLE COKING COAL	DEEP-OTHER (INCLUDING LATENT COKING RESERVES)	TOTAL RESERVES SEAM AND COUNTY	SULFUR (0/0)	ASH (0/0)	FREE SWELLING INDEX
WEST KENTUCKY	DUNBAR	BUTLER	-	38	-	-	38	1.8	13	-
			-	53	-	-	53	1.7	10	-
	MAIN NOLAN	EDMONDSON	-	53	-	-	53	1.7	10	-
			-	26	-	-	26	1.9	05	-
	MINING CITY	MUHLENBUR	-	26	-	-	26	1.9	05	-
			-	-	-	-	14	1.1	07	-
	I B	UNION	-	-	-	-	14	1.1	07	-
			-	76	-	-	76	1.5	15	-
	12	OHIO	-	76	-	-	76	1.5	15	-
			-	-	-	-	58	1.5	15	-
TOTAL WEST KENTUCKY	13	OHIO	-	3.8	-	2.3	61	1.8	07	-
			-	-	-	62	62	1.8	08	-
	13	WEBSTER	-	-	-	-	-	-	-	-
			-	27	-	-	27	1.3	05	-
	4	CHRISTIAN	-	-	-	-	-	-	-	-
TOTAL WEST KENTUCKY			258	-	-	157	415	-	-	-
TOTAL, ALL STATES			611	2464	2540	1442	7057	-	-	-

Sulfur Percent	Assigned (Dedicated)			Unassigned (Undedicated)		
	0.9	1.0-1.4	1.5-1.9	0.9	1.0-1.4	1.5-1.9
Illinois	70	102	235	1	29	34
Indiana	36	6	---	5	25	30
West Kentucky	---	---	---	---	---	---
All states	136	108	235	6	54	64

Figure 5-39A. Summary of dedicated coals by state, summarized from Midwest Coal Producers Institute data, 1966. Table should be used independently only after carefully reference to study objectives and constraints.

	Metallurgical Grade ¹ Coking Coal (as mined or after cleaning)	Marginal ² Coking Coal	Latent ³ Coking Reserves
Coking Property	Strong/Moderately Strong	Moderately Strong	Good
Ash Content	8.0%	8.1-12%	12.1-15%
Sulfur Content	1.25%	1.26-1.75%	1.76-3.0%

Figure 5-40 Criteria to identify varying classes in coking coal, as adopted for study purposes.

- 1 From Sheridan (1968).
- 2 Coals with somewhat higher percentages of ash and sulfur are used in some instances in coking-coal mixes. The ash content of the mix should not exceed the limits established for metallurgical-grade coals.
- 3 Probably will not be used and therefore are potential reserves presumably available for air pollution control purposes.

	Total Undedicated ¹ Strip (in place) Coal	Total Undedicated ¹ Deep (in place) Coal	Recoverable Strip Coal	Recoverable Deep Coal	Total Recoverable
Illinois	115	374	81	182	263
Indiana	2038	911	1427	456	1883
West Kentucky	258	157	181	78	259
Total all states	2411	1442	1689	716	2405

Figure 5-41. Recoverability of undedicated low sulfur coals (millions of tons) available for air pollution control. Table should be used independently only after careful reference to study objectives and constraints.

¹ Less all reserves of probable coking quality.

5.4.4 Potential Discovery of Additional Low Sulfur Coal Reserves

There is little doubt that additional drilling and expanded coal sampling (and analysis) programs will (a) extend the boundaries of identified low sulfur areas, and (b) possibly discover new low sulfur reserves. In southeastern Illinois, for example, little is known about the sulfur content of deep coals below the No. 5 coal. A deep drilling program designed to obtain cores for chemical analysis would contribute the needed data.

In a study of the Harrisburg (No. 5) coal in southeastern Illinois, Hopkins (1968) concluded that:

"....conventional electric logs can be used to determine coal thicknesses, especially where the coal, a high-resistive unit, is overlain by low-resistive shale. Complications occur when a high-resistive unit such as a limestone occurs near the top of the coal. It is suggested that with proper caution and with adequate lithologic control, these logs, of which there are about 70,000 in Illinois, can be used to a greater extent in delineating coal resources."

As a means for locating probable (additional) low sulfur coal areas, the study team suggests that petroleum companies may provide useful new data by giving careful attention to recording the presence and elevation of coal seams encountered in drilling.

Progress is being made in establishing indirect criteria for exploring low sulfur coal reserves. A report by Hopkins (1968) who, while noting exceptions exist, concluded that:

"The principal geological feature that can be used to predict occurrence of relatively low-sulfur No. 5 Coal north and east of Saline County is the appearance of a gray silty shale and St. David Limestone. When this shale....attains a thickness of about 20 feet or more, the No. 5 Coal has been found to have a relatively low-sulfur content (usually less than 2.5 percent)....Because of the geologic similarity of this occurrence of relatively low-sulfur No. 5 Coal to the well-known low-sulfur area of No. 6 Coal in Franklin, Williamson, and Jefferson Counties, it is suggested that this type of occurrence (i.e., the intervention of a gray shale between the coal and the overlying marine black shale and/or limestone) provides a valuable clue to the nature of the coal."

Such thick shale sequences lying above coal seams may be indicative of low-sulfur coals in some areas and lead to discovery of new reserves in MWCF.

In West Kentucky, the No. 12¹⁹ is cut in southwestern Webster and Western Hopkins County areas by a major ancient channel. Quality variations in the vicinity of the channel were noted by TVA, who described the area as follows:

"The characteristics of this (No. 12, designated No. 13 by TVA) seam vary consider-

ably on either side of a broad channel west of Clay. There the No. 13 coal interval is occupied by an Anvil Rock sandstone channel which extends to the northeast an undetermined distance across the Providence and Bordley quadrangles....Coal quality southeast of the channel is relatively poor and washing is required to bring the coal up to TVA standards. Northwest of the channel the character of the No. 13 coal changes. In this area northwest of the channel the coal is of good quality and free of partings. It has been shipped raw to TVA by a strip coal operator in the area."

Furthermore, some producers report (No. 13) low-sulfur coal in the area although insufficient sulfur data are available for independent confirmation.

While it is difficult to draw conclusions based on such limited evidence, it is suggested that the information contained in the Hopkins (1968) report represents a possible indirect technique for locating low-sulfur coal which could be used to increase defined low sulfur reserves.

It is considered unlikely that any very large low sulfur reserves -- even in relatively thin seams -- will be found in the near future. An indication of low sulfur, No. 6 coal in Macoupin County is suggested by Gluskoter and Simon (1968). With further exploration it is anticipated that low sulfur reserves approaching 250 million tons might be located. It is concluded that in view of the extensive studies already conducted by coal companies and the Illinois State Geological Survey, new low sulfur reserves substantially less than those already identified ^{1/} will be found in Illinois.

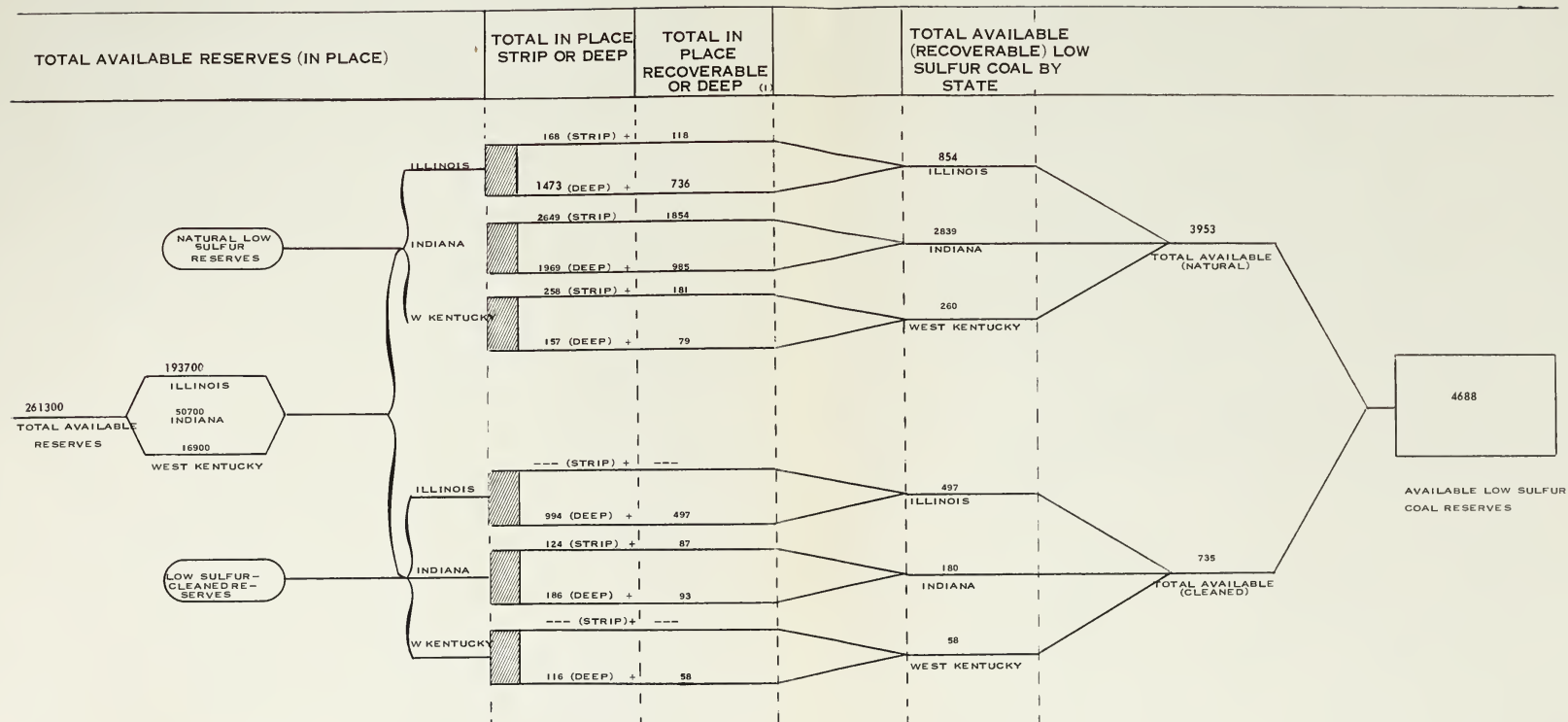
The discovery of additional low sulfur reserves in West Kentucky is unlikely, although additional sulfur data in the No. 4 and No. 6 seams is desirable and may reveal small reserves, i.e., less than 0.2 billion tons. Low sulfur No. 13 coal is reported by producers in Ohio County, and additional data collection in this area should produce reserves amounting to less than 100 million tons.

Neavel (1960) maintained that the search for low sulfur coal might best be confined to the Lower and Upper Block Coals or Coal IV in Indiana; the study team concurs with Neavel's view but would also include Coal V and the Minshall Coals. Significant Coal V reserves (amounting to 401 million tons), for example, occur in Sullivan and Gibson Counties, Indiana. Although progress has been made in identifying low sulfur reserves, more coal quality information is needed. It is not anticipated that new reserves in Indiana will exceed 1.0 billion tons.

That rapid changes in sulfur content can occur over short distances is revealed by Dr. Charles Weir (personal communications, 1970) who referenced an informal analysis of sulfur distribution by members of the Indiana Geological Survey coal section. It was concluded (based on data available at the time) that regional trends in sulfur content were difficult to establish. It is possible that rapid changes from high to low sulfur coals in Indiana, as observed in this study, are related (a) directly to an abundance of

¹⁹ This was correlated as the No. 13 coal by TVA geologists. Some controversy exists over differentiating the No. 12 and No. 13 coals in this area.

^{1/} While this report was being completed, reports of low sulfur coal in Wabash and Edwards Counties, Illinois, and Gibson County, Indiana were received. Further information is unavailable, excepting that deposits are irregular.



(1) INCLUDING SUPPLEMENTARY DATA FOLLOWING GEOLOGICAL ANALYSIS.

FIGURE 5-42. SUMMARY OF LOW SULFUR COAL AVAILABILITY BASED UPON RECOVERABILITY ALONE. IT IS POSSIBLE TO MODIFY ESTIMATES AND REDUCE ESTIMATES IF OTHER ASSUMPTIONS OF AVAILABILITY ARE JUDGED ACCEPTABLE AND INTRODUCED.

Independent use of this figure should include careful reference to study objectives and constraints.

thin and rather discontinuous seams in the state, or (b) indirectly because of the depositional environment which was somewhat different from that in Illinois and Indiana. If new reserves are found in Indiana in sufficient quantities to impact Illinois low sulfur coal availability, it is more than likely that these will be found in relatively thin and/or laterally discontinuous seams with the attendant (especially economic) problems of exploitation.

5.4.5 Summary of Reserves Availability

Recoverability has been used as the principal criterion of availability. Other measures of availability, e.g., stripping ratio, accessibility to current producing areas and dedication have also been quantified for reference purposes. These data can be applied to modify available low sulfur coal information summarized in Figure 5-42.

Low sulfur (<2.0%) coal availability based upon recoverability amounts to 4,688 million tons, or 2,240 million tons of recoverable strip coal and 2,448 million tons of recoverable deep coal. Strip coals can be most speedily exploited for the Illinois market and the majority of strip coals are in Indiana.

6.0 ECONOMIC CONSIDERATIONS

6.1 Introduction

The 4,688 million tons of recoverable low-sulfur coal identified in the reserves analysis in Section 5 for the MWCF represents thirty-six times current production (at MWCF 1968 production rates of 130 million tons per year) and is based on:

- limited sulfur content data--information regarding sulfur content is available for approximately 25% of the identified reserves over 24 inches in seam thickness.
- conservative analysis--geologists employ conservative techniques in analyzing potential reserves; i.e., analysis is based on identified coal reserves and sulfur content.
- 1970 mining technology--50% and 70% recoverability for deep and strip mines, respectively, are considered valid estimating factors; however, if coal value increases substantially, the stated recoverability factors will increase under the pressure of heightened demand.

The economic implications of these observations suggest that:

- the 4,688 million ton coal reserve in the MWCF is a minimum value--while geological analysis would conclude, with a high probability, that 4,688 million tons of low sulfur coal are recoverable, economic analysis could suggest with a lower probability, that 10,000, ($\sim 2 \times 4,688$), million tons are recoverable; i.e., approximately 70 times current production.
- there exists sufficient time for action--a supply of less than 10 times current annual production could be considered a "panic" situation, 25-30 times would cause "concern", but a supply of low sulfur coal of greater than 50 times current annual production will permit an orderly fuel transition for pollution control.
- As the value of low sulfur coal increases rela-

tive to alternative sources of energy, techniques will be developed to improve recoverability and cleanability of coal.

The economic effects on the State of Illinois depend on the type of controls that may be implemented. Three control options are considered in this report:

- Option 1: Restrict mining of coal containing sulfur exceeding specified levels. Low sulfur coal, for this study, contains less than 2% sulfur by weight.
- Option 2: Restrict burning of coal containing sulfur exceeding specified levels. This option, then would permit mining of higher sulfur coal for combustion only if the coal were cleaned sufficiently to reduce its sulfur content to the prescribed level.
- Option 3: Restrict sulfur emissions in combustion process effluents to specified levels. This option can be exercised with various alternatives for coal supplier and consumer: cleaning fuel vs. cleaning effluents and/or the utilization of natural low sulfur fuels.

The economic impact of various constraints (e.g., sulfur control legislation) upon the national energy industry resulting from air pollution control programs cannot be quantitatively determined with precision. Because much of the energy industry is subject to a high degree of "public" control--i.e., treated as public monopolies--the classical economic analysis related to free market conditions is essentially precluded. Nevertheless, the economic implications of sulfur control legislation will be identified for each of the three control options at two levels of detail:

- Marco: Refers to the effects of disturbances in Illinois coal production upon other regions of the country.
- Micro: Concerned with effects within Illinois and/or its neighboring states.

6.2 POTENTIAL RECOVERABLE RESERVES - Economic Basis

The estimate of recoverable reserves of low sulfur coal derived in Section 5 (4688 million tons) was obtained with specific constraints based on a mining technology and the economic conditions of 1970. The most important factors determining the cost of mining are seam thickness and overburden; current strip mining practice in the MWCF removes overburden up to 100 feet. As coal available with such overburden is exhausted, highly overburdened coal will be mined by strip or deep mining techniques--provided competitive coals outside the MWCF or other fuels cannot be supplied more cheaply to the users. Further, as natural low sulfur coal reserves are depleted and mining costs rise in attempts to reach the more remote coals, the total cost of mining and cleaning higher sulfur coals available at less remote locations will become competitive with the natural low-sulfur coal. If medium sulfur coals (between two and four per cent) can be cleaned economically, a substantial increase in useable recoverable reserves may result.

In this section, recoverable reserves will be examined as a function of mining cost; which could be compared with costs of obtaining energy from

alternative sources.

6.2.1 Methodology

Two principal factors are considered in this analysis:

- The coal seam characteristics of thickness and overburden.
- The fraction of coal recoverable in cleaning to the 2% level.

The cost of mining increases as deeper or thinner seams are mined; unit cost contours as a function of thickness and overburden, can be developed based on coal values (*values of production as measured by mine shipments, sales or marketable production*) of representative mines in Illinois. Approximation of mining costs for potential new mines were made from the costs assessed for low sulfur reserves in the data bank that included specified seam thickness and overburden characteristics.

To address the second factor, data from Helfinstine et al (1970), indicating the recoverable fraction in cleaning coal of varying sulfur content, were utilized. The unrecoverable (high-sulfur) fraction would be compensated for by additional mining to meet user demand. As shown in Figure 6-1, the recovery limits in cleaning operations designed to obtain a 2% sulfur end product vary from about 20% recovery for 3.5% sulfur raw coal to 100% recovery for 2% sulfur coal. In Figure 6-2, the data from Figure 6-1 is transformed to indicate percent recovery vs. per cent sulfur in raw coal for various desired percentages of sulfur in the end product.

Figure 6-3 depicts the seam thickness and overburden characteristics of Illinois mines that produced more than 500,000 tons of coal in 1967. The dashed line corresponds to the extreme condition denoting maximum costs supportable by present market conditions. A gross approximation of unit mining costs can then be plotted using mined coal values in the U. S. Bureau of Mines Minerals Yearbook. However, such value data for a substantial portion of state production was "withheld to avoid disclosing individual company confidential data";--a trend that has increased markedly in the past few years. Estimates of county coal production, derived from published data, are given in Figure 6-4. Equal unit cost contours can then be drawn as shown in the upper region of Figure 6-5. Estimates of unit costs could be sketched for the deeper, thinner areas in Figure 6-5; but the dearth of data for costs of mining deep thin seams cause the lower right portion of Figure 6-5 to be highly conjectural -- the trend of increasing costs to the lower right side of the figure is evident.

6.2.2 Potential Recoverable Reserves -- Analysis

This analysis comprises the determination of the potential tonnage recoverable for each identified coal deposit with a sulfur content less than 3.5%. The data used in the analysis is summarized in Figure 6-6.

Columns 1-4 and 8 of Figure 6-6 are obtained from the data bank derived in previous sections of this report. The mining cost, column 5, is obtained from Figure 6-5 by entering the overburden and seam

thickness characteristics and noting the approximate cost. Column 6 is the fraction of raw coal that can be washed to a sulfur content of less than two per cent; the values are obtained from Figure 6-2. Since the unrecovered portion of coal would be mined but would not meet the sulfur content criteria, there would be an additional cost incurred by the need to store or dispose of the unused fraction of coal. The effective cost of mining a ton of low sulfur coal is obtained by dividing the mining cost by the recoverability factor; these effective mining costs are recorded in column 7. The effective 2% sulfur coal tonnage available in the ground is obtained by multiplying the recoverability times the tons identified for each coal deposit; these data are shown in column 9.

6.2.3 Effective Low Sulfur Reserves

The effective low-sulfur reserves in the ground are listed by county and unit mining costs in Figure 6-7. In addition, the last column indicates recoverable coal reserves based on 1970 mining recoverability factors (70% for strip and 50% for deep mines). Deposits listed in Figure 6-6 with over 150 feet overburden were calculated on the "deep mines" basis.

The data in Figure 6-7 is summarized in Figure 6-8 for the State of Illinois and plotted in Figure 6-9. This plot shows that approximately 2 billion tons of coal are recoverable with mining costs less than \$6.00. Since the total Illinois coal production for 1969 was less than 65 million tons, the reserves of 2 billion tons previously identified correspond to over 30 times current production.

In Section 6.1, estimates of reserves were made. These estimates are now further examined. The lower curve in Figure 6-9 is the "minimum" curve; i.e., there is high probability that at least the indicated reserves are available. Two factors suggest a strong possibility that additional low sulfur reserves are present:

- Reports were available for only one fourth of the indicated reserves in seams over 24 inches thick.
- Recoverability is based on 1970 technology.

Because only one-fourth of the received data included sulfur content, it cannot be assumed that only one-fourth of the low sulfur coal was reported. An assumption that but one-half of the low-sulfur coal was reported would represent a conservatively reasonable estimate. Technological improvements in mining and cleaning methods tending to improve recoverability are not likely to occur until coal values increase; e.g., at 1970 values it is not economically feasible to replace the coal columns with fabricated structures for roof support in deep mines. At the upper limit of recoverability (100%), the upper curve of Figure 6-9 would represent available reserves. It is assumed, for this discussion, that 50% improvement in recoverability can be achieved. This assumption would yield approximately 2.8 billion tons at \$6.00 mining cost.

Summarizing for the State of Illinois:

- Conservatively, (high probability) 4 billion tons of low sulfur coal are recoverable with 1970 mining and cleaning technology; 2 billion tons are recoverable for less than \$6.00 per ton.

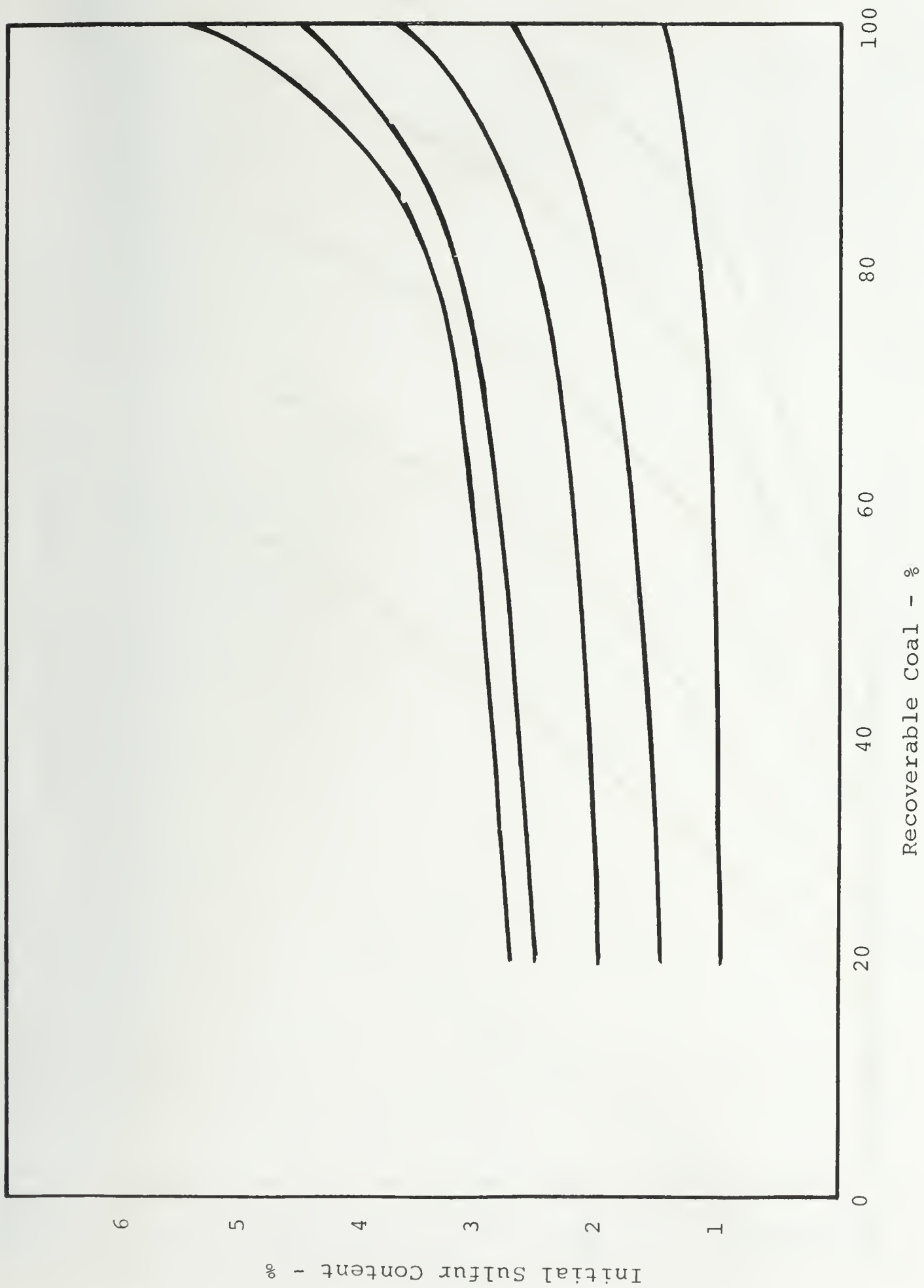
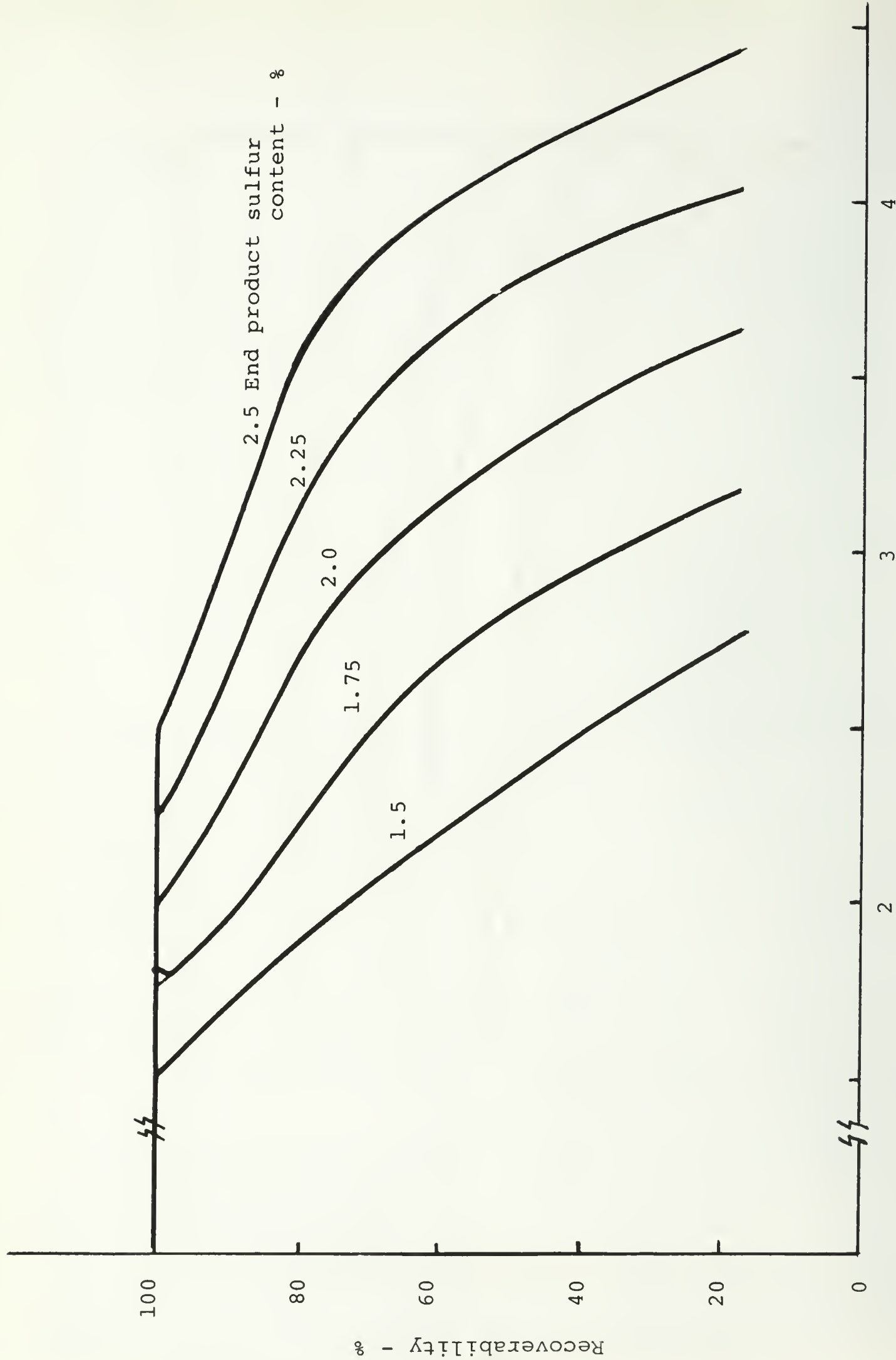


Figure 6-1. Typical Washability Curves, Illinois Coal

Source: Helfinstine, et al, 1970



Initial Sulfur Content - %

Figure 6-2. Recoverability vs. Initial Sulfur Content

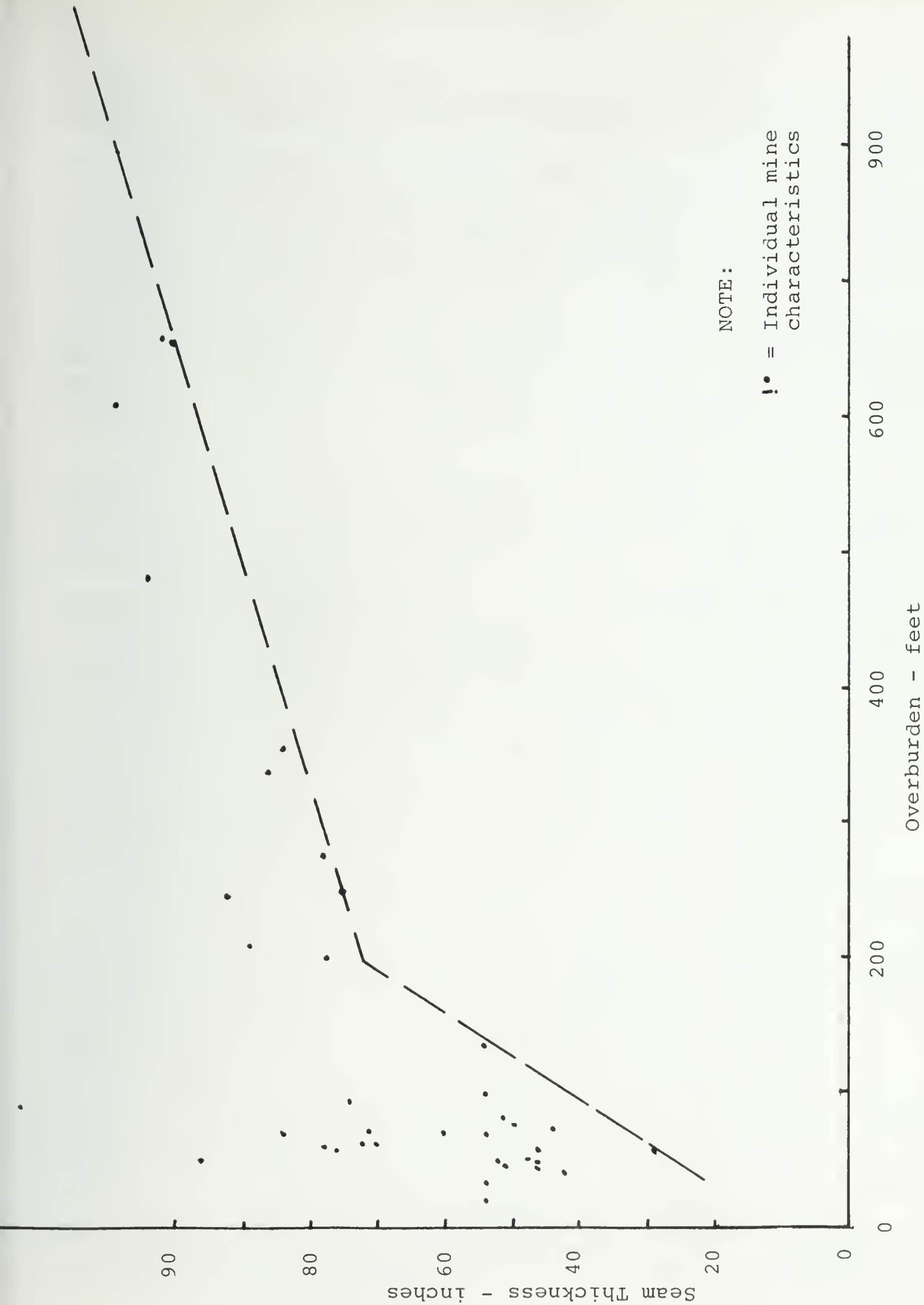


Figure 6-3. Illinois Mine Characteristics

Source: Illinois Dept. of Mines and Mineral Annual Report, 1967

Figure 6-4 Value of Coal Mined - 1968

County	Value - \$ million		Total
	Underground	Strip	
<u>ILLINOIS</u>			
Adams	-	0.09	0.09
Christian	22.15	-	22.15
Douglas	2.72	-	2.72
Franklin	29.40	-	29.40
Fulton	-	28.30	28.30
Gallatin	2.61	1.55	4.16
Grundy	-	1.39	1.39
Jackson	-	0.76	0.76
Jefferson	13.24	-	13.24
Knox	-	8.60	8.60
Logan	0.10	-	0.10
Macoupin	1.21	-	1.21
Mercer	0.06	-	0.06
Montgomery	12.88	-	12.88
Peoria	-	6.54	6.54
Perry	-	39.47	39.47
Randolph	3.79	6.60	10.39
St. Clair	2.67	24.54	27.21
Saline	7.55	5.39	12.94
Stark	-	2.12	2.12
Vermilion	0.27	3.94	4.21
Washington	0.12	-	0.12
Will	-	2.25	2.25
Williamson	11.70	8.68	20.38
Total	110.47	140.22	250.69
<u>INDIANA</u>			
Clay	-	4.46	4.46
Daviess	-	0.04	0.04
Fountain	-	0.10	0.10
Gibson	3.67	0.04	3.71
Greene	-	8.95	8.95
Knox	0.88	-	0.88
Owen	-	0.10	0.10
Parke	-	0.06	0.06
Pike	0.14	10.48	10.62
Spencer	-	0.09	0.09
Sullivan	4.95	8.87	13.82
Vigo	0.32	0.91	1.23
Warwick	0.13	27.49	27.62
Total	10.09	61.59	71.68

County	(\$ million) Total
<u>WEST KENTUCKY (1966)</u>	
Butler	0.66*
Caldwell	0.05
Christian	0.87
Daviess	2.72*
Henderson	0.55
Hopkins	34.43
Muhlenberg	62.51
Ohio	19.81
Union	19.91
Webster	3.00
	<hr/>
	144.51

* 1965

Source: U. S. Bureau of Mines, Minerals Yearbooks, 1966, 1968

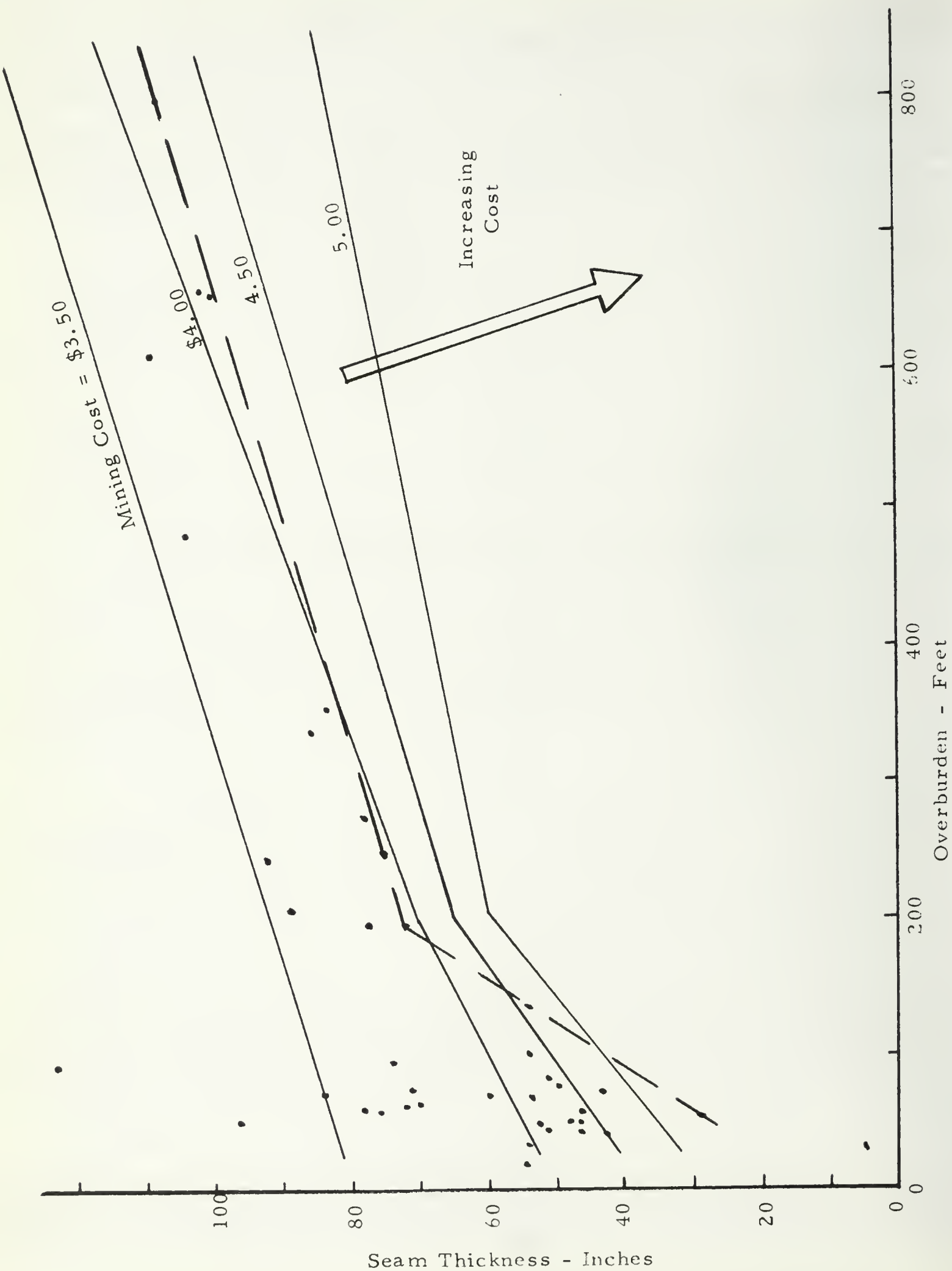


Figure 6-5 Unit Mining Cost Contours

Figure 6-6. Data for Economic Recoverability Analysis

County*	Sulfur %	Thickness Inches	Overburden Feet	Mining** Cost \$/Ton	Fraction Washable to S<2%	Effective** Cost \$/Ton	Reserves mil tons	Effective Reserves mil tons
	3.3	42	980	ND***	0.49	ND	126.3	62
	1.5	65	320	4.90	1.00	4.90	34.4	34
	3.0	69	250	4.40	.67	6.60	207.5	139
	2.6	24	200	ND	.83	ND	82.9	69
	3.5	51	605	ND	.32	ND	157.7	51
	3.5	52	800	ND	.32	ND	143.8	46
	2.8	48	445	ND	.77	ND	149.3	37
	1.3	96	664	4.20	1.00	4.20	92.9	93
	1.5	96	647	4.20	1.00	4.20	189.3	189
	1.5	76	680	5.00	1.00	5.00	14.6	15
	2.0	96	588	4.10	1.00	4.10	106.2	106
	2.5	36	680	ND	.85	ND	2.8	2
	1.9	100	610	4.00	1.00	4.00	23.3	23
	2.7	100	610	4.00	.80	5.00	82.1	66
	1.8	96	615	4.10	1.00	4.10	53.9	54
	1.1	102	410	3.50	1.00	3.50	3.5	4
	1.4	96	550	3.80	1.00	3.80	28.2	28
	3.3	69	305	4.60	.49	9.20	78.7	39
	2.5	60	785	ND	.85	ND	91.2	78
	1.4	32	149	ND	1.00	ND	52.0	52
	1.2	48	50	4.30	1.00	4.30	39.8	40
	1.2	24	(100)	ND	1.00	ND	70.5	71

*

County names withheld to preserve confidentiality of data

**

Does not include the cost of additional preparation to obtain 2%, nor the cost to dispose of the unwanted fraction

ND indicates seam thickness and depth is in region of "no Data" in Figure 6-5; i.e., cost > \$5.00 per ton

Figure 6-6. Data for Economic Recoverability Analysis

County	Sulfur %	Thickness Inches	Overburden Feet	Mining Cost \$/Ton	Fraction Washable to S < 2%	Effective Cost \$/Ton	Reserves mil tons	Effective Reserves mil tons
	2.7	84	150	3.60	0.80	4.50	81.3	65
	1.7	84	150	3.60	1.00	3.60	45.5	46
	3.5	76	50	3.60	0.32	11.30	18.4	6
	2.7	70	70	3.70	0.80	4.60	58.1	47
	2.1	48	1025	ND	0.96	ND	106.2	102
	1.5	87	750	4.70	1.00	4.70	64.6	65
	1.5	84	850	4.90	1.00	4.90	142.2	142
	1.5	97	800	4.40	1.00	4.40	145.3	145
	1.6	84	800	4.80	1.00	4.80	249.7	250
	1.6	66	700	ND	1.00	ND	63.4	63
	3.0	60	700	ND	0.67	ND	148.3	100
	3.4	84	750	4.80	0.41	11.70	213.4	88
	3.4	84	805	4.80	0.41	11.70	142.2	58
	3.3	97	800	4.40	0.49	9.00	98.3	48
	3.2	36	83	ND	0.55	ND	33.6	19
	2.8	24	65	ND	0.77	ND	68.8	54
	1.8	25	75	ND	1.00	ND	14.7	15
	3.5	56	60	4.00	0.32	12.50	114.2	37
	3.0	32	517	ND	0.67	ND	97.3	65
	3.0	40	(400)	ND	0.67	ND	132.7	89
	2.5	35	430	ND	0.85	ND	104.0	85
	3.5	55	330	ND	0.32	ND	182.5	59
	2.4	68	310	4.70	0.88	5.30	107.6	95
	2.4	54	365	ND	0.88	ND	186.6	164

Figure 6-6. Data for Economic Recoverability Analysis

County	Sulfur %	Thickness Inches	Overburden Feet	Mining Cost \$/Ton	Fraction Washable to S<2%	Effective Cost \$/Ton	Reserves mil tons	Effective Reserves mil tons
	3.5	60	380	ND	0.32	ND	103.7	33
	1.8	60	250	ND	1.00	ND	35.1	35
	3.4	60	250	ND	0.41	ND	138.6	57
	3.5	72	360	4.60	0.32	14.40	136.9	44
	3.5	44	280	ND	0.32	ND	7.6	2
	1.1	50	210	ND	1.00	ND	67.2	67
	3.5	50	210	ND	0.32	ND	105.6	34
	3.4	32	504	ND	0.41	17.80	98.4	40
	3.1	34	567	ND	0.62	11.60	109.3	72
	3.3	72	170	3.90	0.49	8.00	8.7	4
	3.3	44	506	ND	0.49	ND	133.8	66
	3.3	72	170	3.90	0.49	8.00	219.0	107
	3.0	84	385	4.00	0.67	6.00	148.1	99
	2.4	41	450	ND	0.88	ND	21.3	19
	3.3	48	240	ND	0.49	ND	159.3	78
	3.5	51	605	ND	0.32	ND	4.9	2
	1.5	84	590	4.50	1.00	4.50	58.7	59
	1.5	60	125	4.10	1.00	4.10	17.3	17
	2.0	42	600	ND	1.00	ND	4.0	4
	1.1	75	250	4.00	1.00	4.00	19.4	19
	2.3	75	250	4.00	0.90	4.40	27.7	25
	3.0	72	90	3.70	0.67	5.50	69.7	47
	3.5	72	125	3.80	0.32	11.90	171.7	55

Figure 6-6. Data for Economic Recoverability Analysis

County	Sulfur %	Thickness Inches	Overburden Feet	Mining Cost \$/Ton	Fraction Washable to S < 2%	Effective Cost S/Ton	Reserves mil tons	Effective Reserves mil tons
	3.5	48	245	ND	0.32	ND	41.5	13
	3.4	45	200	ND	0.41	ND	45.1	19
	2.5	50	755	ND	0.85	ND	71.7	61
	2.5	78	710	4.90	0.85	5.80	107.8	92
	2.4	68	440	5.00	0.88	5.70	117.5	103
	2.6	60	350	ND	0.83	ND	103.7	86
	2.5	56	350	ND	0.85	ND	39.6	34
	2.8	70	225	4.20	0.77	5.50	152.4	117
	2.5	72	220	4.00	0.85	4.70	74.6	64
	3.4	72	220	4.00	0.41	9.80	55.3	23
	3.5	60	100	4.00	0.32	12.50	143.1	46
	2.5	28	(800)	ND	0.69	ND	96.8	67
	1.5	84	150	3.60	1.00	3.60	32.3	32
	3.5	48	220	ND	0.32	ND	162.6	52
	2.0	72	225	4.00	1.00	4.00	106.2	106
	2.0	84	200	3.70	1.00	3.70	219.0	219
	2.3	84	75	3.50	0.90	3.90	20.3	18
	3.4	54	80	4.20	0.41	10.20	46.5	19
	2.7	60	160	4.40	0.80	5.50	157.6	46
	2.5	66	200	4.40	0.85	5.20	216.7	184
	2.5	50	310	ND	0.85	ND	48.4	41
	2.3	80	135	3.70	0.90	4.10	69.1	62
	2.5	72	210	4.00	0.85	4.70	146.8	125
	3.2	45	75	4.60	0.55	8.40	37.3	21
	3.4	75	65	3.70	0.41	9.00	54.4	22
	3.3	72	65	3.70	0.49	7.50	159.3	78
	2.9	68	190	3.80	0.73	5.20	232.7	170

Figure 6-6. Data for Economic Recoverability Analysis

County	Sulfur %	Thickness Inches	Overburden Feet	Mining Cost \$/Ton	Fraction Washable to S < 2%	Effective Cost S/Ton	Reserves mil tons	Effective Reserves mil tons
	2.4	28	36	5.00	0.90	5.60	18.9	17
	3.1	60	740	ND	0.62	ND	149.3	93
	1.9	36	70	4.90	1.00	4.90	9.3	9
	2.4	36	70	4.90	0.88	5.60	3.1	3
	1.8	36	35	4.70	1.00	4.70	28.6	29
	2.8	48	250	ND	0.77	ND	162.6	125
	2.5	48	540	ND	0.85	ND	155.9	133
	3.0	40	60	4.70	0.67	7.00	65.0	44
	3.5	48	75	4.40	0.32	13.70	56.4	18
	2.5	48	250	ND	0.85	ND	134.4	114
	1.9	96	160	3.40	1.00	3.40	3.3	3
	1.5	96	150	3.40	1.00	3.40	3.3	3
	1.9	84	75	3.50	1.00	3.50	2.9	3
	3.3	85	200	3.70	0.49	7.50	126.3	62
	3.0	70	300	4.50	0.67	6.70	237.1	159
	0.6	75	40	3.70	1.00	3.70	2.6	3
	2.2	95	55	3.30	0.93	3.50	128.0	119
	3.5	72	65	3.70	0.32	11.50	44.8	14
	3.4	65	240	4.70	0.41	11.50	206.7	85
	3.3	28	(450)	ND	0.49	ND	94.8	47
	3.3	35	495	ND	0.49	ND	59.3	29
	3.2	30	480	ND	0.55	ND	96.4	53
	1.2	32	150	ND	1.00	ND	105.1	105

Figure 6-7.

Illinois Unit Mining Costs and Effective
Low Sulfur Coal Reserves

Unit Cost to produce coal, 5 2% (\$/ton)	Low Sulfur + Cleanable Reserves In Ground (mil tons)	Recoverable Low Sulfur + Cleanable Reserves (mil tons)
13.30	62	31
4.90	34	17
6.60	139	70
8.90	69	34
3.50	4	2
3.80	28	14
4.00	23	12
4.10	160	80
4.20	282	141
5.00	80	40
8.10	37	18
8.40	2	1
9.20	39	20
19.40	97	48
-	-	-
-	-	-
6.50	12	8
9.40	75	38
10.60	38	26
6.70	78	39
3.60	46	32
4.30	40	28
4.50	65	46
4.60	47	33
6.00	123	86
11.30	6	4
6.70	102	51
3.80	383	191
4.40	145	73
4.70	65	33
4.80	250	125
4.90	142	71
5.40	63	31
8.40	100	50
9.00	48	24
11.70	146	73

Figure 6-7.

Illinois Unit Mining Costs and Effective
Low Sulfur Coal Reserves

Unit Cost to produce coal, 5 2% (\$/ton)	Low Sulfur + Cleanable Reserves In Ground (mil tons)	Recoverable Low Sulfur + Cleanable Reserves (mil tons)
9.30	19	13
5.40	15	10
7.00	54	38
12.50	37	26
10.80	65	33
10.20	89	44
5.30	95	48
6.70	164	82
8.20	85	42
17.50	59	30
5.10	35	17
6.00	67	34
12.40	57	28
14.40	44	22
16.50	33	17
18.70	34	17
20.60	2	1
11.60	72	36
17.80	40	20
8.00	4	2
13.50	66	33
8.00	107	54
6.00	99	50
7.70	19	9
12.70	78	39
4.00	19	9
4.10	17	12
4.40	25	12
4.50	59	30
5.50	47	33
6.70	4	2
11.90	55	39
19.40	2	1

Figure 6-7. Illinois Unit Mining Costs and Effective Low Sulfur Coal Reserves

Unit Cost to produce coal, 5 2% (\$/ton)	Low Sulfur + Cleanable Reserves In Ground (mil tons)	Recoverable Low Sulfur + Cleanable Reserves (mil tons)
-	-	-
4.70	64	32
5.50	117	59
5.70	103	51
5.80	92	46
6.40	86	42
6.60	34	17
7.40	61	30
9.80	23	12
12.50	46	32
15.10	19	10
19.40	13	6
10.90	67	34
-	-	-
3.60	32	22
3.70	219	110
3.90	18	13
4.00	106	53
19.40	52	26
10.20	19	13
4.10	62	43
4.70	125	62
5.20	354	177
5.50	46	23
7.20	41	21
7.50	78	55
8.40	21	15
9.00	22	15
5.60	17	12
9.20	93	47
4.70	29	20
4.90	9	6
5.60	3	2

Figure 6-7. Illinois Unit Mining Costs and Effective Low Sulfur Coal Reserves

Unit Cost to produce coal, 5 2% (\$/ton)	Low Sulfur + Cleanable Reserves In Ground (mil tons)	Recoverable Low Sulfur + Cleanable Reserves (mil tons)
3.40	7	4
3.50	122	85
3.70	3	2
6.70	159	111
7.00	44	31
7.30	114	57
7.40	133	66
7.50	62	31
8.10	125	63
11.50	99	52
13.70	18	13
7.30	105	53
13.30	53	26
14.50	29	14
14.70	47	24

Figure 6-8. Illinois Effective Low Sulfur Coal Reserves vs. Unit Mining Cost

Unit Mining Cost (\$/ton)	Effective Low Sulfur Reserves In Ground (mil tons)	Cumulative Eff. Reserves In Ground (mil tons)	Effective Low Sulfur Reserves Recoverable (mil tons)	Cumulative Eff. Res. Recoverable (mil tons)
3.40	7	7	4	4
3.50	126	133	87	91
3.60	78	211	54	145
3.70	222	433	112	257
3.80	411	844	205	462
3.90	18	862	13	475
4.00	148	1,010	74	549
4.10	239	1,249	135	684
4.20	282	1,531	141	825
4.30	40	1,571	28	853
4.40	170	1,741	85	938
4.50	124	1,865	76	1,014
4.60	47	1,912	33	1,047
4.70	283	2,195	147	1,194
4.80	250	2,445	125	1,319
4.90	185	2,630	94	1,413
5.00	80	2,710	40	1,453
5.10	35	2,745	17	1,470
5.20	354	3,099	177	1,647
5.30	95	3,194	48	1,695
5.40	78	3,272	41	1,736
5.50	210	3,482	115	1,851
5.60	20	3,502	14	1,865
5.70	103	3,605	51	1,916
5.80	92	3,697	46	1,962
6.00	289	3,986	170	2,132
6.40	86	4,072	42	2,174
6.50	12	4,084	8	2,182
6.60	173	4,257	87	2,269
6.70	507	4,764	285	2,554
7.00	98	4,862	69	2,623
7.20	41	4,903	21	2,644
7.30	219	5,122	110	2,754
7.40	194	5,316	96	2,850
7.50	140	5,456	86	2,936
7.70	19	5,475	9	2,945
8.00	111	5,586	56	3,001
8.10	162	5,748	81	3,082
8.20	85	5,833	42	3,124
8.40	123	5,956	66	3,190

Figure 6-8. Illinois Effective Low Sulfur Coal Reserves vs. Unit Mining Cost

Unit Mining Cost (\$/ton)	Effective Low Sulfur Reserves In Ground (mil tons)	Cumulative Eff. Reserves In Ground (mil tons)	Effective Low Sulfur Reserves Recoverable (mil tons)	Cumulative Eff. Res. Recoverable (mil tons)
8.90	69	6,025	34	3,224
9.00	70	6,095	39	3,263
9.20	132	6,227	67	3,330
9.30	19	6,246	13	3,343
9.40	75	6,321	38	3,381
9.80	23	6,344	12	3,393
10.20	108	6,452	57	3,450
10.60	38	6,490	26	3,476
10.80	65	6,555	33	3,509
10.90	67	6,622	34	3,543
11.30	6	6,628	4	3,547
11.50	99	6,727	52	3,599
11.60	72	6,799	36	3,635
11.70	146	6,945	73	3,708
11.90	55	7,000	39	3,747
12.40	57	7,057	28	3,775
12.50	83	7,140	58	3,833
12.70	78	7,218	39	3,872
13.30	115	7,333	57	3,929
13.50	66	7,399	33	3,962
13.70	18	7,417	13	3,975
14.40	44	7,461	22	3,997
14.50	29	7,490	14	4,011
14.70	47	7,537	24	4,035
15.10	19	7,556	10	4,045
16.50	33	7,589	17	4,062
17.50	59	7,648	30	4,092
17.80	40	7,688	20	4,112
18.70	34	7,722	17	4,129
19.40	164	7,886	81	4,210
20.60	2	7,888	1	4,211

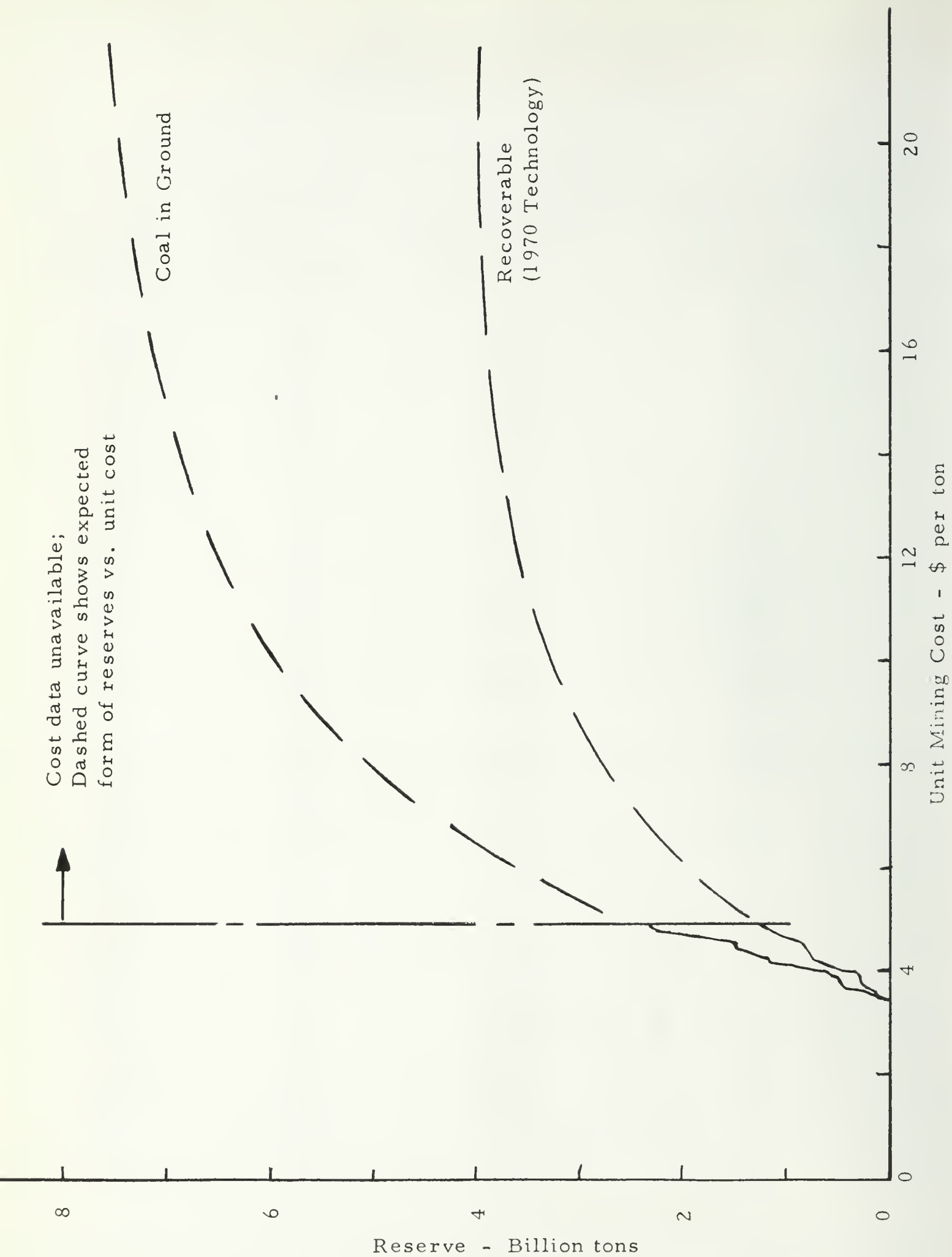


Figure 6-9. Natural plus Cleanable ($S \leq 2\%$) Coal Reserves in Illinois

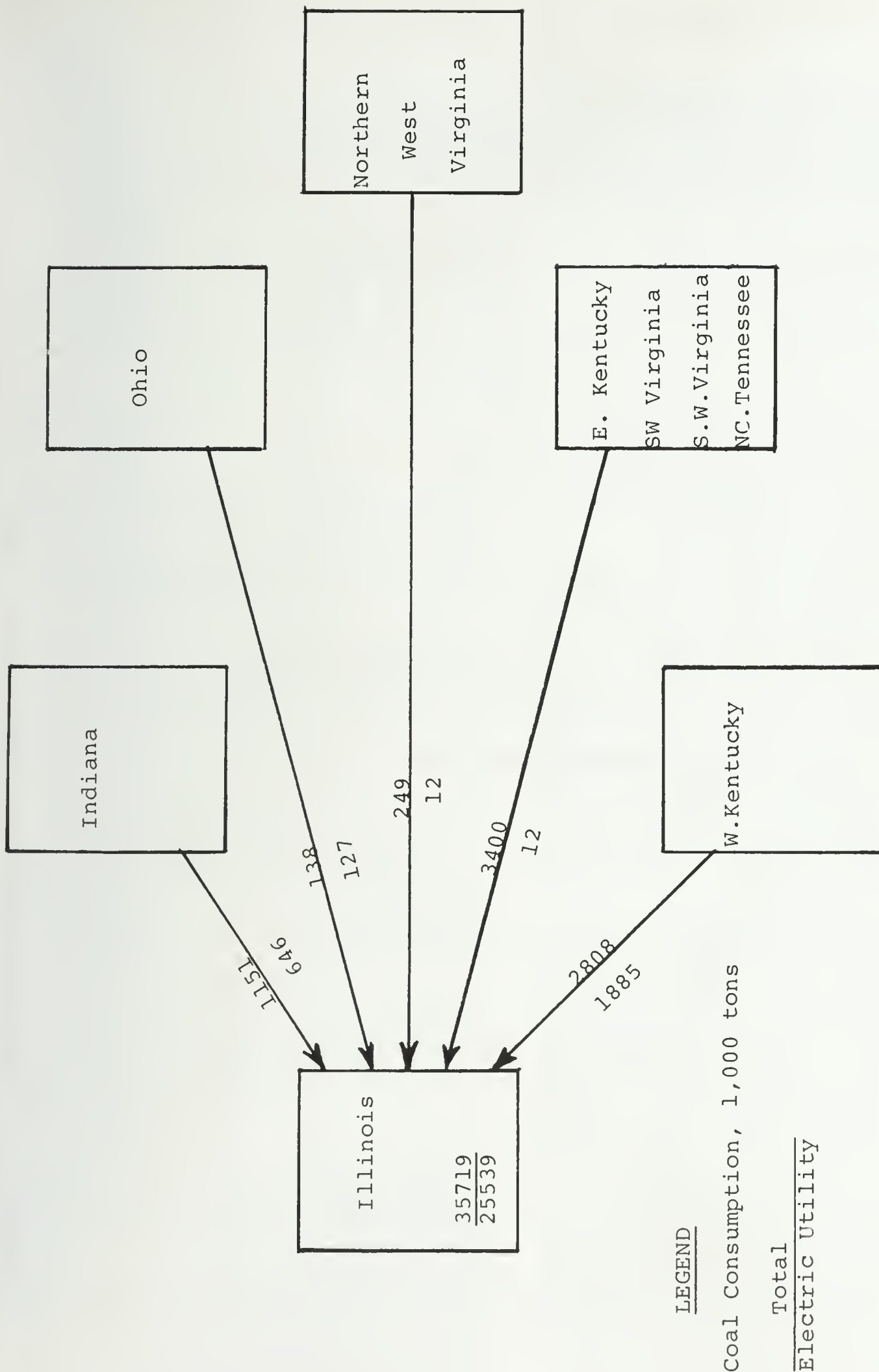


Figure 6-10. Illinois Coal Consumed and Source

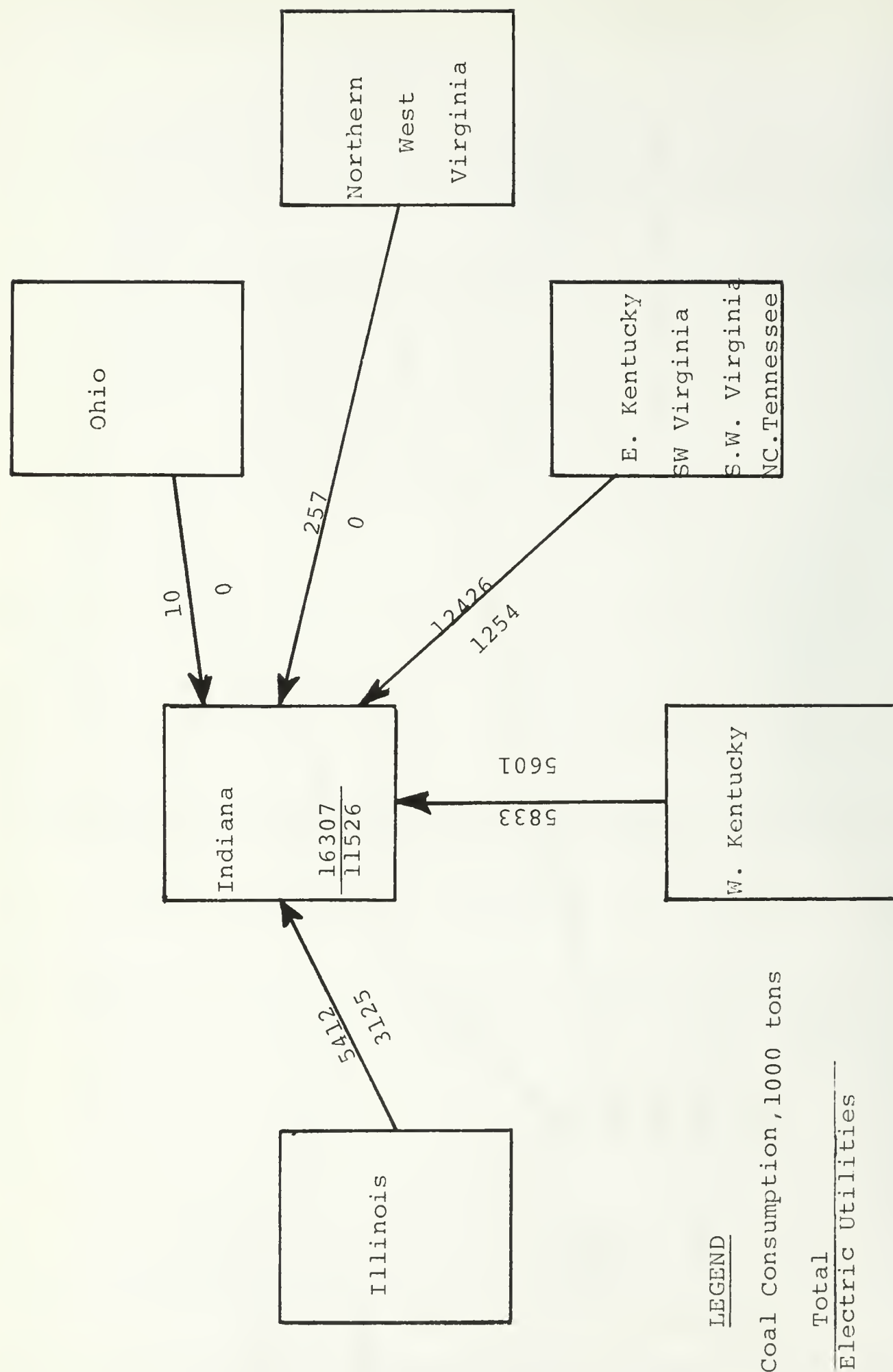


Figure 6-11. Indiana Coal Consumed and Source

Source: U. S. Bureau of Mines Minerals Yearbook, 1968

- Speculatively, (lower probability) 12 billion tons of low sulfur may be recoverable; approximately 4.2 billion tons may be recoverable for less than \$6.00 (--allows \$1.00

per ton for improved recoverability).

- Converted to multiple of year's production (1970 production = 65 million tons)

Basis	Reserves		Supply - Years			
			Growth Rate - %			
	Total mil tons	@ C < \$6 mil tons	0		5	
			Total	C < \$6	Total	C < \$6
Conservative	4,000	2,000	62	31	29	19
Speculative	12,000	4.200	186	65	47	30

6.3 ECONOMIC EFFECTS

6.3.1 Macro Effects

The primary consumers of Midwest coal are within several hundred miles of the MWCF. Energy sources for other regions of the country are, generally:

- East Coast – Oil and gas piped from the Gulf states' reserves or imported from foreign sources and/or Appalachian coal.
- Gulf Coast – Oil and gas are locally available.
- West Coast – Oil and gas from California oil fields; and recently, electric energy generated in in other southwestern states is transported electrically to southern California.
- Mountain and some Plains states – hydroelectric power.
- Appalachian states – huge coal reserves with good coking quality support the Middle Atlantic states as well as foreign users.

Steam coal for Illinois and Indiana electric utilities originate primarily within each using state. Figures 6-10 and 11 show the coal consumed in Illinois and Indiana and their sources. It is seen that almost 90% of the steam coal for Illinois' electric utilities originates within the state. Distribution of coal mined in MWCF is shown in Figure 6-12.

Because each of the energy demand regions listed above is self-supplying, it is apparent that potential pollution control legislation relative to coal use within the State of Illinois would have minor effect on a national (macro) level.

6.3.2 Micro Effects

The principal economic effects resulting from prohibitions upon the use of high sulfur coal will occur in specific regions of the state and will be functions of the type of control imposed, e.g., the possible control options discussed in Section 6.1. Petroleum and coal provide less than 2% of the manufacturing value of the Illinois GNP, see Figure 6-13. However, with the presently anticipated (1970) national energy shortages, sudden restrictions in established energy supply patterns (i.e., Illinois coal) may severely disrupt industry until new supply patterns are established (i.e., new low sulfur mines

developed in Illinois or other states and/or substitute fuels); the degree of perturbation is dependent upon the type of control and rate of implementation. The economic effects for each of the three control options are reviewed in the following sections.

6.3.3 Option 1: Economic Effects

On a statewide basis, a time sequence of coal revenue patterns is shown in Figure 6-14. The heavy-line curve indicates a projected coal production value based on implementation of a pollution control plan that would immediately (1971) restrict the mining of coal containing more than 2% sulfur. If it is assumed that the Illinois mines are presently working near their effective productive capacity (labor as well as mechanical aspects), the value of their coal production would decrease \$109 million (relative to 1968 production value of \$250 million); i.e., over 40% of the Illinois coal industry would be halted. As a corrective reaction rapid increase in low sulfur coal mine development would be expected; but because only a few new mines (of the order of 1 million tons annual capacity) are developed annually. The countering effect would be limited.

Nor would the tempo of the development be expected to accelerate significantly, for the sudden increase in required labor and equipment for mine development may quickly exhaust available resources, especially in regions in which construction of new mines is presently at a high rate. This situation could be aggravated by the loss of mines that would result from the recent adoption of stricter mine safety codes. Moreover, it may take several years to recover even half of the 109 million dollars annual coal values (at 1969 prices). On the other hand, additional "value" could result from higher prices caused by shortages in useable coal supplies.

An instantaneous implementation of a plan to halt mining of non-low sulfur coal would result in a step decrease in coal supply and is the "worst case" situation. If a 5-year transition period to recover mining capacity is assumed, nearly \$300 million in coal production value could be lost to other sources of energy over the 5-year period (assuming such sources were available). In the long-term this loss might be recovered because during this period the "other sources" would be depleting their most accessible (lower cost) reserves. This perturbation

Figure 6-12. Distribution of Coal Originating in MWCF

Thousand tons - 1967

From To	MWCF	Illinois	Indiana	W. Kentucky
Ohio	2,011	-	-	2,011
Indiana	27,037	5,516	15,842	5,679
Illinois	42,748	38,510	1,088	3,150
Michigan	2,685	1,149	571	965
Wisconsin	9,840	6,108	620	3,112
Minnesota	3,593	2,695	491	407
Iowa	4,065	3,569	77	419
Missouri	5,679	5,751	-	28
N & S Dakota	10	10	-	-
Nebraska/ Kansas	2	2	-	-
Georgia/ Florida	5,059	-	-	5,059
Kentucky	14,938	2,446	-	12,492
Tennessee	7,388	92	-	7,296
Alabama/ Miss.	6,930	21	-	6,909
Ark/Lou/ Okla/Tex.	22	5	-	17
Canada	65	-	8	57
Not Revealable	313	123	169	21
	132,385	65,897	18,866	47,572
Distributed within originating station MWCF %	84,723 64	38,510 58	15,842 84	12,492 26

Source: U. S. Bureau of Mines, Mineral Industry Surveys, 1967

Figure 6-13

MANUFACTURING VALUE ADDED IN ILLINOIS
(IN 1963 DOLLARS), 1947, 1954, 1958, and 1963

	1947 (\$1,000)	Per Cent of Total	1954 (\$1,000)	Per Cent of Total	1958 (\$1,000)	Per Cent of Total	1963 (\$1,000)	Per Cent of Total
Total Manufacturing Value Added	\$8,230,3972	100%	\$10,967,228	100%	\$11,776,628	100%	\$14,557,060	100%
SIC 20 Food and Kindred	1,070,952	13.0%	1,385,848	12.6%	1,623,808	13.8%	2,043,377	14.0%
22 Textiles	56,064	0.7	61,823	0.6	61,058	0.5	55,931	0.4
23 Apparel	253,016	3.1	239,470	2.2	251,949	2.1	264,651	1.8
24 Lumber and Wood	73,058	0.9	69,717	0.6	78,400	0.7	86,711	0.6
25 Furniture and Fixtures	177,984	2.2	187,643	1.7	184,213	1.6	208,337	1.4
26 Pulp, Paper, and Products	208,317	2.5	256,316	2.3	284,417	2.4	380,378	2.6
27 Printing and Publishing	823,466	10.0	809,963	7.4	918,520	7.8	1,193,866	7.9
28 Chemicals	457,998	5.6	657,127	6.0	812,877	7.0	1,215,130	8.8
29 Petroleum and Coal	208,134	2.5	215,759	2.0	208,714	1.8	248,537	1.7
30 Rubber	(D)		123,204	1.1	173,608	1.5	305,547	2.1
31 Leather	124,407	1.5	135,141	1.2	117,978	1.0	116,726	0.8
32 Stone, Clay, and Glass	258,058	3.1	326,998	3.0	424,704	3.6	490,419	3.4
33 Primary Metals	1,037,944	12.6	1,057,934	9.6	899,656	7.6	1,158,132	8.0
34 Fabricated Metals	961,589	11.7	1,174,532	10.7	1,219,568	10.4	1,369,080	9.4
35 Non-electric Machine	1,870,103	22.7	2,080,437	19.0	1,908,265	16.2	2,181,630	15.0
36 Electrical Machines	1,041,243	12.7	1,195,754	10.9	1,415,781	12.0	1,781,288	12.2
37 Transportation Equip.	386,890	4.7	555,523	5.1	534,003	4.5	595,239	4.1
38 Instruments	162,410	2.0	255,064	2.3	314,870	2.7	474,959	3.3
39* Miscellaneous Manuf.	200,012	2.4	178,975	1.6	344,239	2.9	364,692	2.5

(1) From 1954 Census (others from 1958)

(2) Adjusted by 1947 All Commodity Index - 1963 Business Statistics.

SOURCES: U. S. Census of Manufactures 1954, 1958, 1963.

*Includes SIC 19.

could be avoided by a planned transition period (here estimated to be approximately 5 years) to phase out the highest sulfur coal mines as new low sulfur mines are developed.

The relative economic impact on certain localities within the state would be severe. The immediate impact would be loss of coal-related revenue and loss of coal production employment in those counties mining high sulfur coal; activity would increase rapidly in counties containing mineable low sulfur reserves. Counties with over 100,000 tons production in 1968 or low sulfur reserves are ordered in Figure 6-15 according to low sulfur reserves. The \$109 million loss is reflected in the drop in production at the time of implementation (assumed 1971) depicted in Figure 6-14. Six counties for which coal mine employment is 10% or more of county employment (Christian, Gallatin, Fulton, Saline, Montgomery and Stark in order of employment) will be severely impacted. Essentially, 3,600 primary jobs (miners) and three to four thousand secondary jobs (supporting services) will be lost in already depressed areas. However, similar jobs will be available in counties fortunate enough to contain low sulfur coal reserves. Consequently, when considered on a state-wide basis, the job loss will be temporary rather than sustained and generally less widespread than that experienced in the MWCF during the 1950's when mining employment declined from 30,000 to less than 10,000.

Moreover, the implementation of Option 1 on an instantaneous basis is not possible because of several factors affecting the energy market in 1970. For example, a sudden restriction on mining high sulfur coal would cause electric power plants to seek alternative sources of coal or even alternative fuels if specific plants have multiple fuel burning capabilities. However, as consistently reported in the trade magazines and national press, nearly all fuel supply sources are operating at near capacity. Coal fired plants have reported as little as several days' coal supply on hand; rail coal cars are in short supply. Coal mines have been closed because of new safety regulations for mines; natural gas transmission companies cannot expand gas supplied high volume customers. Even the rate of oil imports is constrained by available tanker space--exclusive of import quota legislation, and nuclear powered electric generation plants have lagged many months behind scheduled on-line dates. The current situation is that energy supply lines to most regions of this country are operating near maximum capacity. The current strain upon the energy supply is termed an "energy crisis". Therefore, a sudden halt in mining higher sulfur coals in key producing areas such as the MWCF would cut off those sources of supply rather than causing a shift to low sulfur supply lines, because it would be extremely difficult (expensive) to compete for fuel normally supplied other customers. Even if it were possible to compete, this would result in a deficit to consumers in other localities.

The type of competition described above would develop as a consequence of a halt in the MWCF high-sulfur coal supplies caused by legislative restraints. This is apparent even when the problem is narrowed to the supply of low-sulfur coal to electric utilities. An obvious strategy to increase the supply of low-sulfur coal would be to exploit the great low-sulfur coal reserves in Colorado, Wyoming and Montana. Irrespective of economic considerations, this does not appear to be a feasible alternative for there

does not presently exist easily-developable excess production capacity to supply an additional 30 million tons of coal annually (approximate 1970 coal consumption for electric utilities in Illinois), nor does there exist railroad car capacity to transport the coal if it were available. However, over an extended period of time, transition could be made, but not without a shift in cost relationships. Two factors are considered:

- Costs of transportation
- Costs of modifying electric power plant furnaces to accept low-sulfur coal

Nathan Associates, in examining the transportation problem of western coal have shown that the cost of long haul, high-volume bituminous coal unit train rates approaches 4 mills per ton mile (Figure 5-16). The distance between Denver and Chicago is approximately 1,000 miles and between the MWCF and Chicago approximately 300 miles; the ton-mile rate for 1 million tons per year is 7 mills per ton mile. Therefore, for 30 million tons delivered at a rate of 1 million tons per year to Illinois power plants, annual transportation costs would be (approx.):

Coal Source	Distance Miles	Rate mills/ton mi.	Annual Cost \$ million
MWCF	300	7	63
Colorado	1,000	4	120

Even if low sulfur coal supplies were available, the characteristics of electric power plant furnaces preclude direct substitution of low sulfur coal. The higher ash softening temperature of low sulfur coal requires modification of mechanical handling systems of the furnace to burn low sulfur coal. An estimate of anticipated modification costs for generating plants in Ohio (which has an installed capacity equivalent to Illinois) was \$450 million (National Economic Research Assoc., 1968). Illinois utilities would require, then, about \$450 million for modification and another \$150 million (5% excess capacity - 750 megawatts; @ \$200 million per 1,000 megawatts) to build excess generating capacity for periods of shutdown for changeover. Consequently, utilities face new capital requirements of the order of \$600 million.

Capital costs for developing a typical mine of 2.4 million tons annual capacity have been estimated to be approximately \$13 million (American Mining Congress 1969 Coal Conference) which includes \$2.5 million for a preparation plant. To supply 30 million tons of coal to the Illinois electric power plants and 20 million tons to other states' electric power plants (as is done presently) would require 21 new mines to maintain the necessary production to meet the 1970 electric power plant requirements of Illinois. If three mines could be developed each year, on the average, a seven year transition period would be required. Total capital costs would be:

Location of Consumption	Mines Number	New Cost \$ mil	Equip. Recovered Cost \$ mil
Illinois	13	169	81
Others	8	104	52
Total	21	273	133

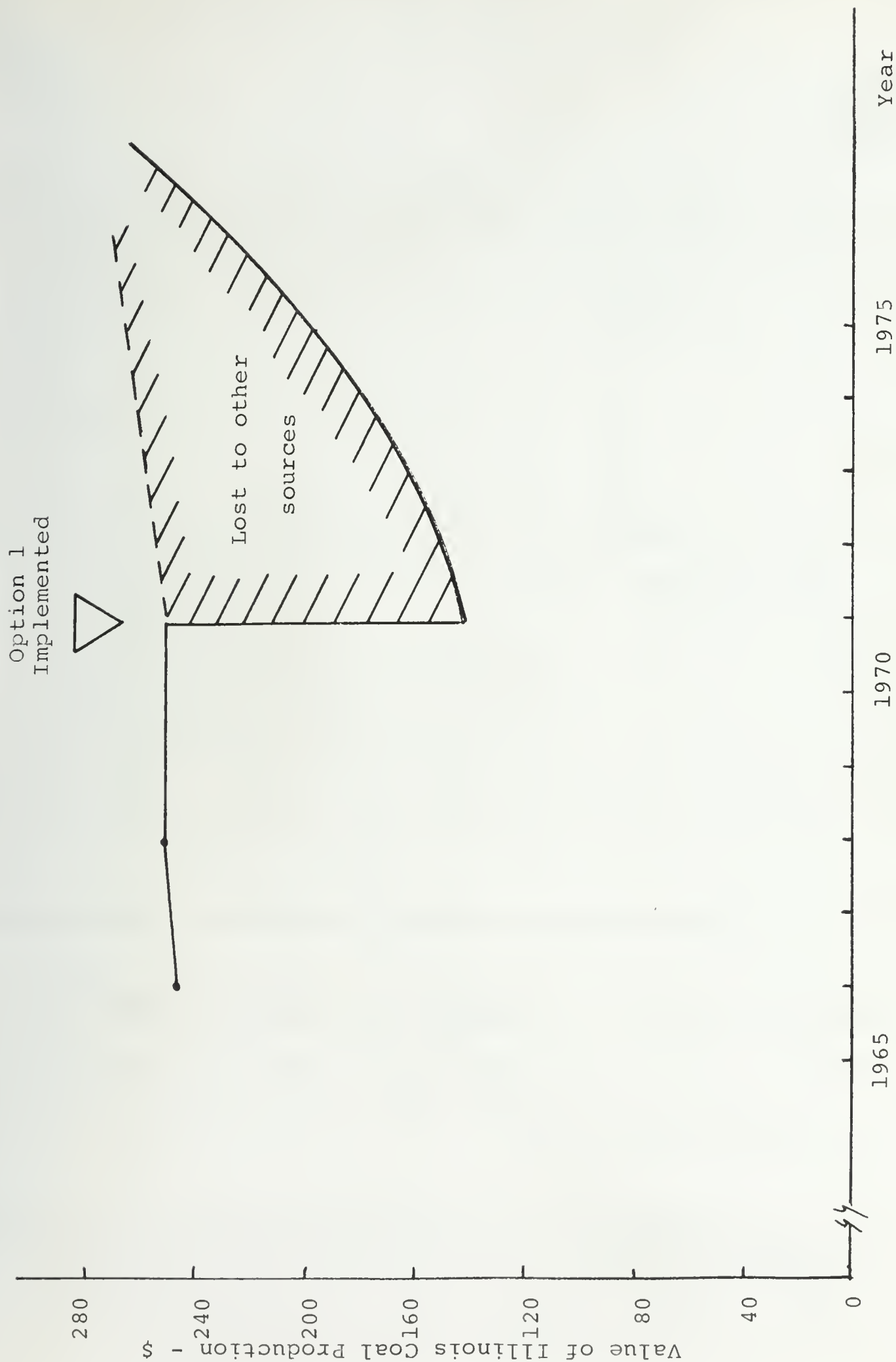


Figure 6-14. Projected Coal Production Value

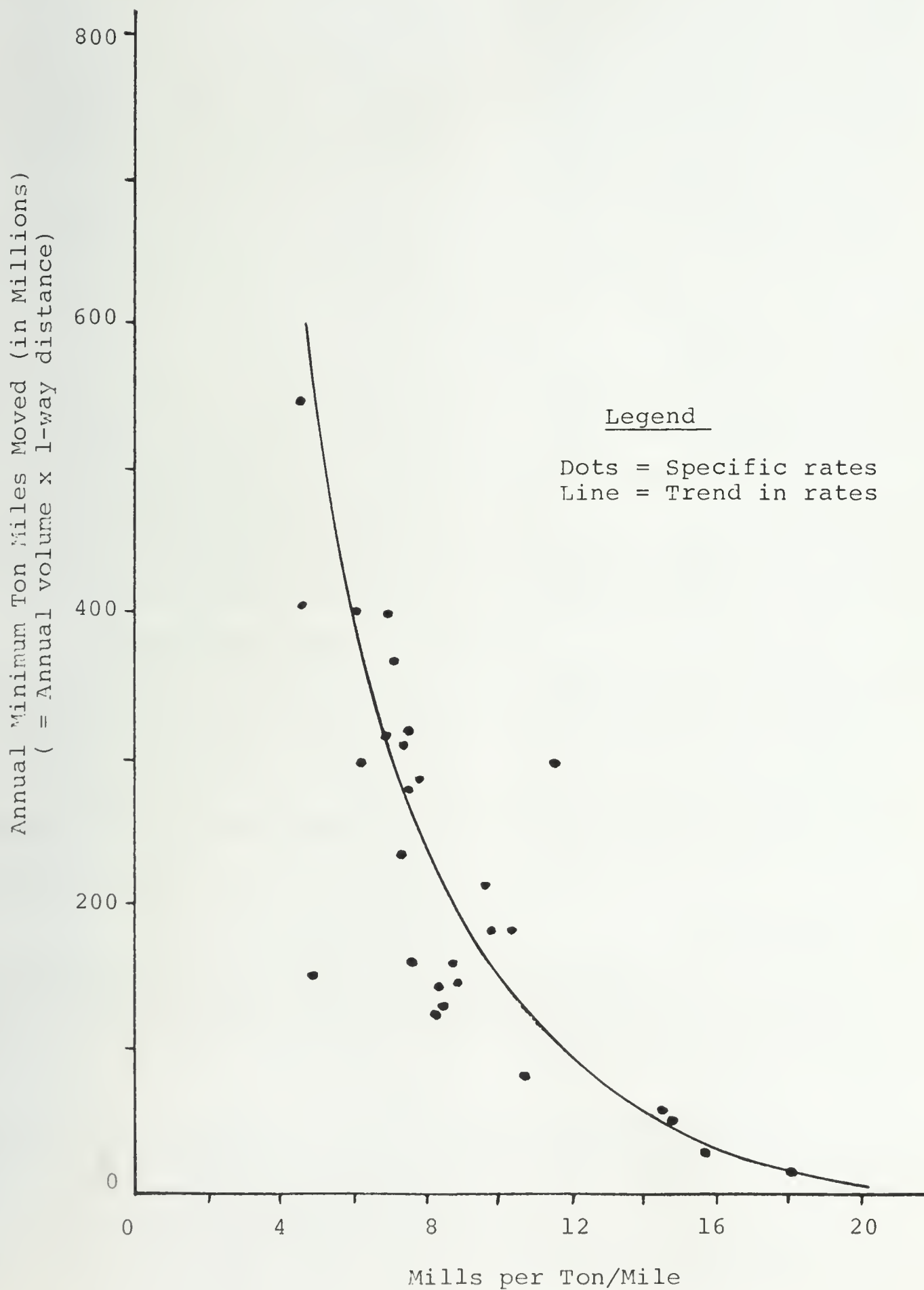
ILLINOIS

County	Lo S Reserves (mil tons)	1968 Production (mil tons)	Coal Value (Mil \$)	# Employees	% Coal to County Employ- ment
Jefferson	1,048	3.2	[13.2]	804	10
Franklin	406	7.1	[29.4]	1,533	30
Jackson	208	0.3	0.8	67	1
Madison	102	-	-	-	-
Perry	95	10.4	[39.5]	494	13
Will	38	0.6	[2.3]	[96]	-
Clinton	34	-	-	-	-
St. Clair	32	7.1	[27.2]	452	< 1
Knox	15	2.3	[8.6]	125	< 1
Williamson	12	4.9	20.4	1,082	12
<hr/>					
↓ Loss					
Fulton	-	6.8	28.3	951	15
Christian	-	5.3	[22.2]	928	40
Saline	-	3.2	[12.9]	608	15
Montgomery	-	3.1	[12.9]	637	10
Randolph	-	2.7	[10.4]	438	1
Peoria	-	1.7	[6.5]	275	< 1
Gallatin	-	1.0	[4.2]	399	32
Vermilion	-	0.8	4.2	139	< 1
Douglas	-	0.7	[2.7]	133	3
Stark	-	0.6	[2.1]	96	10
Grundy	-	0.4	[1.4]	[64]	-
Macoupin	-	0.3	[1.2]	172	4
<hr/>					
Loss		26.6	109.0	4,840	
State Total		62.4	250.7	9,538	
% Loss		43	43	51	

NOTE: [] denotes estimate

Figure 6-16

REPRESENTATIVE UNIT TRAIN TARIFFS FOR
EASTERN & MIDWESTERN MOVEMENT



The reduction in investment costs obtained by recovery of equipment from closed mines would be substantial (perhaps 60-80%) depending on equipment age and capacity, proximity to present mines, type of mine (strip or deep), and location of rail or barge loading facilities. Each potential mine relocation would have to be examined on its own merits and specific characteristics of the relocation route assessed. Relocation of strip mine equipment would be more readily accomplished than development of new deep mines; and further, most of the equipment should be recoverable. If it is assumed that one-half the new mines would be strip mines and the other half deep mines, (1969 Illinois output: 30.2 mil tons underground; 34.7 mil tons strip) and relocation costs would equal 20% and 80% of new-mine capital costs for strip and deep, respectively; the relative recoverable costs could be assessed. These are shown in the last column of the above table.

For the Illinois electric power industry, a comparison of costs between low sulfur coal imported from Colorado vs. coal from Illinois yields: (based on a 30 million ton annual consumption).

6.3.4 Option 2: Economic Effects

Restricting coal-as-burned to specified sulfur content reduces the impact on the coal mining industry of Illinois in several ways:

- additional reserves are made available by permitting cleanable coals to be utilized, thereby impacting fewer mines.
- high sulfur coal could be shipped to other states for consumption, and low sulfur coal imported from other states for consumption in Illinois. This assumes that the use of high sulfur coal is acceptable in other states.

The impact of limiting sulfur in coal-as-burned is summarized by county in Figure 6-17, which, when compared with Figure 6-15, shows the decreased impact this control option offers (\$45 million vs. \$109 million loss – for instant implementation). As in Option 1, a planned transition period would reduce the perturbation in coal supply; i.e., since most electric utilities in Illinois burn the higher sulfur coals, the same 50 million tons (discussed under Option 1) would have to be replaced by new mines; however, less mobility of labor and equipment to new counties is required.

6.3.5 Option 3: Economic Effects

The third potential for control of sulfur compounds in the atmosphere is removal of the compounds from the effluent resulting from the combustion process. Several economically promising methods of removing sulfur from flue gases have been developed to the point of testing in large scale plants.

	Colorado	Illinois
Construct mines (\$ mil)	169	81
Modify furnaces (\$ mil)	600	600
Transportation charge (\$mil/yr)	120	63

It is assumed that modern technology is utilized in both Colorado and Illinois and operating costs should be nearly equal.

Control of sulfur in effluents released to the atmosphere will have the least economic impact on local regions compared to Options 1 and 2; most of the coal reserves will be available for utilization by the users. In any case the energy user can expect higher costs for energy supplied under the new control conditions. A typical application of this option is explored below for one suggested approach to the problem.

The addition of dry dolomite to the flue gas stream, under laboratory conditions, has been shown to remove over 98% of SO₂ in the flue gas. Operating costs (without credit for potential saving in operating other equipment) are approximately 75¢/ton (Frankel, 1968 Includes 10¢/ton of coal for solid waste disposal @ 10% ash content) of coal burned. This is one control technique currently being examined, and if it were used by the Illinois electric utilities (consuming 30 million tons of coal in 1970), additional costs of operations would be approximately \$22.5 million. Capital costs are estimated to be about \$2.20 per kilowatt (Frankel, 1968, includes 10¢/ton for coal for solid waste disposal @ 10% ash content) of plant capacity. It is, therefore, concluded that about \$31 million for sulfur effluent control would be required for the approximately 14 million kw installed capacity. If the same excess capacity requirements were allowed for changeover as in Options 1 and 2, an additional \$150 million dollars in capital costs would be required, yielding a total of \$181 million. The impact on the producers would be negligible since the energy supply system would remain intact, utilizing the mines already operating, and other sources (out-of-state coal and substitute fuels) would not face sudden demands caused by elimination of substantial coal reserves.

6.3.6 Summary - Economic Effects

All three options would require time for implementation. It is apparent that the present "fuel crisis" precludes instantaneous implementation of low sulfur coal limitations for electric power plants. The pipelines are being utilized to near capacity. It is felt that a step decrease in fuel production would be disruptive. The time needed to install large capital equipment would make the costs of the equipment an item of secondary importance and the economic effects of an instantaneous shift to low sulfur fuels would not be measurable because it would cause shutoff of a major portion of electric power in Illinois--an unacceptable alternative.

The sudden increase in capital equipment required for new mines and modified power plants is another problem. The table below summarizes first year incremental costs based on capital costs spread over a 5-year transition period and additional transportation costs to move coal from Colorado:

Option	New Mines in		Cost to Power Plants \$ Million		Cost to Mines & Plants \$ Million		# Illinois Mine Employees Affected
			New Mines in		New Mines in		
	Ill.	Colo.	Ill.	Colo.	Ill.	Colo.	
1	16	34	120	177	136	211	4,840
2	16	34	120	177	136	211	1,884
3	-	-	59	116	59	116	-

Figure 6-17. Option 2: Impact by County

<u>ILLINOIS</u>		Lo S	1968	Coal		%
		Reserves	Production	Value	Employees	Coal to
		+ Cleanable	(mil tons)	(mil \$)	(number)	County
County		(mil tons)				Employer
Jefferson		1,342	3.2	[13.2]	804	10
Williamson		885	4.9	20.4	1,082	12
Franklin		753	7.1	[29.4]	1,533	30
Vermilion		749	0.8	4.2	139	1
Saline		658	3.2	[12.9]	608	15
St. Clair		427	7.1	[27.2]	452	1
Macoupin		403	0.3	[1.2]	172	4
Jackson		327	0.3	0.8	67	1
Madison		272	-	-	-	-
Woodford		234	-	-	-	-
Perry		228	10.4	[39.5]	494	13
Douglas		208	0.7	[2.7]	133	3
Grundy		125	0.4	[1.4]	[64]	-
Montgomery		118	3.1	[12.9]	637	10
Marshall		112	-	-	-	-
Menard		107	-	-	-	-
Knox		106	2.3	[8.6]	125	< 1
Jasper		102	-	-	-	-
White		93	-	-	-	-
Livingston		89	-	-	-	-
Hamilton		78	-	-	-	-
Peoria		78	1.7	[6.5]	275	< 1
Shelby		67	-	-	-	-
McLean		66	-	-	-	-
LaSalle		65	-	-	-	-
Christian		62	5.3	[22.2]	928	40
Will		41	0.6	[2.3]	[96]	-
Clinton		34	-	-	-	-
Kankakee		19	-	-	-	-
Tazewell		19	-	-	-	-
Woodford		17	-	-	-	-
Mason		4	-	-	-	-

↓						
Loss	Fulton	-	6.8	28.3	951	15
	Randolph	-	2.7	[10.4]	438	1
	Gallatin	-	1.0	[4.2]	399	32
	Stark	-	0.6	[2.1]	96	10

Loss			11.1	45.0	1,884	
State Total			62.4	250.7	9,538	
% Loss			18	18	20	

[] denotes estimate

7.1 CONCLUSIONS

As a result of the independent study herein completed, and within the limits of the methodology employed, it is concluded:

1. That the total available reserves of low (less than 2%) sulfur coal in the MWCF, based on assumed recoverability factors, amount to 4,680 million tons. This figure represents a total of natural low sulfur and low sulfur cleaned coal-without consideration of mineability.
2. That the production of a significant portion of the available recoverable reserves is probably not feasible because it exists in thin seams, in small blocks, and in locations so remote from currently producing operations that the extension of these operations into new low sulfur coal reserves areas (assuming property availability) would be difficult in view of the time required to open new mines and the limited availability of new mining and cleaning equipment.
3. That in areas in which production of low-sulfur coal is presently being carried on, significant increase in production is not considered feasible because of the lack of excess unused mining capacity. They essentially operate at full production.
4. That because of the generally self-supplying nature of the major energy demand areas in the U. S., prohibitions upon the use of high sulfur coal in Illinois will primarily affect the MWCF and have little effect outside the area.
5. That such prohibitions would cause significant disturbances in the energy supply in the MWCF in the near term for the following reasons -
 - a. Production in counties with low sulfur coal would increase to the extent possible (considering the previously referenced equipment and property constraints) because of increased demand.
 - b. Production in counties possessing solely high sulfur coal would decrease because of a diminished demand.

c. A significant energy market shift and labor relocation would follow.

d. Because of the lack of unused production capability and the time required to bring new mines into production, a net coal shortage would develop in the short term. This shortage could probably not be relieved by the importation of out-of-state coal because of the time lag in new mine development in areas with large reserves of low sulfur coal, but without significant excess production capacity.

6. That in the long-term, the MWCF, by increasing production of low-sulfur coal, could satisfy its own needs at probably lower costs than those expected with out-of-state suppliers.

7. That the expense and time required to modify combustion equipment to accept low sulfur coal in place of high sulfur coal would aggravate the time problem for changeover, but would not affect the price competition between coal produced within and without the MWCF because it represents a cost common to the use of all low-sulfur coals.

SUMMARY:

An immediate requirement for changeover from high to low sulfur coal will result in a net near-term fuel shortage in the MWCF--that gives no promise of relief by importation of coal from alternate sources or by substituting other fuels which are currently in short supply in the areas of their primary use.

An orderly changeover from high to low sulfur coal could be made within a reasonable time (5 years) without a significant fuel shortage, but at a higher price.

If it is assumed that effective emission suppression will probably be possible within this time frame (5 years), it is suggested that the basic decision remaining would be the choice of approach to the control program--either an increased effort of producers to bring new low-sulfur reserves into production or the installation by the user of emission control equipment. The first approach would result in increased costs to the producer; either approach would mean increased cost to the user, and in both cases the cost would be passed on to the consumer.

APPENDIX A

COAL PREPARATION

1.0 GENERAL¹

Coals mined in the U. S. vary widely in sulfur content, ranging from as low as 0.2 to as high as 7 percent or more, by weight, on a dry basis. The sulfur content of Illinois coal ranges approximately from less than 1% to 6%. Sulfur occurs in coal in three principal forms: (a) *It is present in organic combinations as part of the coal substance*, (b) *as pyrite*, and (c) *as sulfates*. The amount of sulfate sulfur in raw coal is normally small and of little significance. The organic sulfur is distributed throughout the coal substance in molecular combination and cannot be removed without materially altering the nature of the coal substance. The pyritic sulfur, however, can vary from a low of 40 percent to as high as 80 percent of the total sulfur, and some reduction in this pyritic sulfur can be achieved by cleaning, the degree depending upon the manner in which it is dispersed in the coal.

Pyrite occurs in coal as discrete particles in a wide variety of shapes and sizes. R. D. Saltsman categorized pyrites in coal as:

1. *Rounded masses called "sulfur balls" or nodules which range in size from a small fraction of an inch to very large.*
2. *Lens-shaped masses which may be thought of as flattened sulfur balls which vary greatly in thickness and lateral extent.*
3. *Veins of pyrite consisting of vertical or inclined veins or fissures filled with pyrite ranging in thickness from thin flakes up to several inches thick in some cases.*
4. *Small discontinuous veinlets of pyrite, a number of which sometimes radiate from a common center which may be a small sulfur ball.*
5. *Small particles or veinlets disseminated in the coal.*

All coals contain veins of pyrite and small particles or veinlets, and some coals contain all five of the principal forms.

The total amount of pyritic sulfur varies from seam to seam, and even within a given seam or mine. Likewise, there is great variation in the size and shape of pyrite inclusions for coals having similar amounts of total pyritic sulfur. The degree of pyrite liberation at any given stage of crushing and grinding also varies greatly among coals. With some coals, good pyrite removal is obtained by merely washing the nominal sizes produced in the mining operations, and little additional pyrite is liberated by further size reductions. Other coals show some pyrite liberation with each successive stage of reduction, while still other coals show no significant pyrite liberation when they are pulverized to conventional pulverized size coal (60 to 85 percent minus 200 mesh). These variations are directly related to the mode of occurrence of the pyrite.

Coal preparation generally consists of crushing, screening, and the removal of free impurities from raw coal. The free impurities include high ash bands, rock, ash forming material, water and moisture, and pyrites. The removal of organic sulfur has not yet been incorporated in the coal preparation process, because of high cost. Much research is being done in this area.

1.1 REMOVAL OF ORGANIC SULFUR FROM COAL

The organic sulfur in coal is chemically bound in a complex manner to the coal substance, and little is known about the exact forms in which it occurs. Its removal, however, would require drastic treatment, much of which would also result in removal of the sulfur occurring in the form of pyrites. Solvent extraction of coal, liquefaction, and gasification have all been examined as possible methods for removal of most, if not all, of the sulfur from coal. Chemical and bacterial treatments have also been suggested. Many of the research efforts have been significant and have reached the pilot plant stage. Table A-1 shows the status of several significant coal research projects.

1.2 REMOVAL OF PYRITIC SULFUR FROM COAL

In coal preparation processes, pyritic particles are usually removed by gravitational separation, the pyrite having a much greater density than coal. To separate the pyrite from coal, the pyrite must first be released from the coal substance by a crushing process. The extent of separation, and hence the efficiency of coal cleaning depends on the shape, size and distribution of the pyrite particles and the particular process used. By present standards, the coal industry possesses the necessary technology for cleaning coarse coal. Much research and development have been conducted in fine coal cleaning in recent years. The conventional coal preparation process generally consists of the following steps:

A. *Raw Coal Preparation:* The objective of raw coal preparation is the control of mining operations for the purpose of yielding raw coal of certain quality which can be cleaned to satisfy predetermined market requirements. First of all, care in the mining operation could minimize the roof or floor impurities. Secondly, by selective mining according to the washability properties, the proper cleaning process could be matched to the raw coal for better cleaning efficiency and better yield. Raw coal blending could maximize uniformity in run of mine coal properties. A well-planned raw coal preparation is essential to achieve high efficiency in the coal cleaning process at the lowest possible operating cost.

B. *Crushing and Size Reductions:* The degree to which the pyritic sulfur can be removed in the coal cleaning plant depends, to a large extent, on the degree of pyrite liberation from crushing and size reduction. Liberation of pyrite varies quite widely with different coals at a given stage of crushing. With some coals one crushing operation could liberate most of the pyrite particles. Little additional liberation is obtained by further size reduction. For some other coals, further size reduction still could significantly reduce the pyrite particles. Washability studies are quite important for the determination of the optimum crushing size or sizes. During the washability test of Illinois coals conducted by the Illinois State Geological Survey, coal samples were crushed to a top size of 3/8 of an inch, then screened into 3/8 inch x 14 mesh, 14 mesh x 100 mesh, and 100 mesh x 0 fractions. Washability studies were made on the 1 1/2" x 0, 3/8" x 14 mesh, 14 mesh x 100 mesh fractions. It was found that gravity separations of very fine coal (less than 100 mesh) are difficult with any coal and are particularly difficult with Illinois coals, which are quite porous. Table A-2 lists the average percentages of total and pyritic sulfur (dry basis) at 5 recovery values and three size ranges for the 40 Illinois coals tested. The percentages of total and pyritic sulfur were usually lower in the finer coal sizes, but the differences were not great enough to consider fine grinding of these coals as an effective procedure for sulfur reduction. However, a few exceptions to this average trend indicate that fine grinding might produce beneficial effects from some coals.

C. *Screening:* After crushing, coal of proper size or sizes are collected through a screening process, in order to obtain maximum recovery in the coal cleaning process.

D. *Concentration of Coarse Coal:* After crushing and screening the impurities will be separated from coal. Wet concentration processes utilizing water or other liquids are generally used. The use of air-operated jigs is quite common where water is the coarse coal washing medium. Other types of units include hydro-separators and washers. The more common practice with jigs is to crush and recirculate or re-wash part or all of the middlings. Dense medium washers are widely used by some other companies. In this process coal is separated from its impurities in a dense-medium. Three types of separating media have been commonly used: water solutions of salts, organic liquids, and finely di-

vided solids suspended in water. It is important that the medium used should be physically stable, easily removable from the product, capable of being adjusted to achieve a predetermined gravity of separation, and capable of being maintained over the range of specific gravity likely to be used.

E. *Concentration of Fine Coal:* In the cleaning of fine coal, air equipment (dry concentration) is sometimes used as well as water or dense-medium (wet) processes. Air equipment includes air flow tables and air jigs. In these systems air flows counter to the pull of gravity and separates coal from the impurities. There are several kinds of wet concentration methods: concentrating tables, jigs, lounders, flotation methods, dense-medium cyclone, hydro-cyclone, Humphrey spiral, etc.

On the concentrating table the coal and the impurities are separated by the oscillation of the table and a flow of water.

In the flotation methods, the crushed and the screened coal is fed into a water bath which is constantly being aerated with small bubbles of air. The flotation agent is then added to coat the particle surface, and subsequently establishes an air-adhering surface on the coal which is lifted to the water surface by the air bubbles. The impurities will be left to adhere to water and sink to the bottom. Particle floatability increases with an increase in the coal surface and with a decrease in mass.

The combination of gravitotational and centrifugal forces are used to separate coal from impurities in the dense-medium cyclone, hydro-cyclone, and the Humphrey spiral. Some investigators have suggested the desirability of combining several cleaning processes to provide maximum clean coal yield. B. S. Taylor investigated the use of fine mesh screening on the classifying cyclone products then re-treating the 100m x 0 from the classifying cyclone overflow in froth flotation.

F. G. Miller investigated the removal of sulfur and ash by the combination of flotation and hydro-cycloning. He also investigated the combination of flotation, hydro-cycloning and tabling. Hydro-cyclones tend to throw extreme fines of all gravities to their clean coal product. They are best used in combination with froth flotation if high yields are to be obtained. Combining processes would require additional equipment expenditures. However, if low sulfur coal becomes the prime commodity, combining of processes may become an attractive option to reduce high sulfur coal to a product of very low sulfur content.

F. *Drying, Dust Removal:* Processes have also been developed for drying, removal of dust, addition of calcium chloride to prevent freezing, and surface oiling for cleanliness.

G. *Blending:* In the Office of Coal Research Annual Report 1969, it was stated that other possibilities, at the mine site, for reducing corrosive properties include the use of locally purchased or mines corrosion-retarding additives such as limestone or dolomite. Another method is the blending of corrosive and noncorrosive coals, possibly from different ores of the same mine.

A combination of these techniques may prove to be the most advantageous.

Methods used to produce noncorrosive coals can also serve for pollution control. However, 2 to 12 times as much neutralizing material may be needed to control pollution. Conversely, the amount of neutralizing material needed to control air pollution would, in most cases, exceed the amount needed to control high-temperature corrosion. According to results of the OCR study, the most corrosive coal tested would require on addition of 1.6 percent calcium oxide as measured on a coal basis to eliminate high-temperature corrosion.

To control both sulfur gas emissions and boiler corrosion, it is desirable to maintain an optimum balance between the sulfur level of the coal and the alkaline earths retained in the coal or added to the coal. Conventional cleaning, using gravity

techniques, can remove most of the pyritic sulfur and thereby reduce the total sulfur by 50 percent or more. This greatly reduced the alkaline earth requirements. Coal preparation processes might be designed not only to reduce the sulfur but increase alkaline earth percentages as well.

2.0 WASHABILITY STUDIES

The study of the washability characteristics of coal could provide a basis for evaluating the potential of pyritic sulfur removal. Under the auspices of NAPCA, The Bureau of Mines is performing tests on coal samples from major coal beds in the United States (Illinois coal basin included). The Illinois State Geological Survey is undertaking a study specifically an Illinois coal under a NAPCA contract.

Washability studies are conducted in a laboratory to determine the potential reduction of ash or sulfur for a coal from any given location. Basically, this is done by placing samples of coal in solutions that have suitable gravity and determining the percentage of the "float" and "sink" fractions. Chemical analyses can also be made on the float and sink fractions. Solutions with varying specific gravities can be used to determine the relationship between the chemical analyses and, the percentage of sink (commonly called "reject" or "refuse") or between the chemical analysis and the percentage of float (commonly called "recovery"). Laboratory float-sink data generally provide results that represent the maximum cleaning capabilities of a particular coal.

2.1 WASHABILITY STUDIES ON ILLINOIS COALS:

Preliminary results from the washability study being conducted by the Illinois State Geological Survey were published in "Environmental Geological Notes", which is reproduced in this report. The primary aim of this investigation was to study the washability characteristics of Illinois coals, with particular emphasis on the quantity, distribution, and varieties (forms) of sulfur occurring in Illinois coals. The studies could provide a basis for determining how much pyritic sulfur could be removed from Illinois coals by conventional coal cleaning methods and also for evaluating the pyritic and total sulfur contents of coal mine refuse.

Some significant results or conclusions from the first phase of investigation of some forty coal samples are summarized below:

1. The Illinois coals sampled from active mines and tested for this study indicated that only a few could be prepared to a sulfur content of 1.5 percent or less. These samples were relatively low in sulfur when mined.
2. Illinois raw coals appear to contain total sulfur ranging from 3 to 5 percent. This study indicated that most of these coals will retain from 2.5 to 4 percent sulfur with 80 percent recovery.
3. The float coal fractions (clean coal) usually had less sulfur when the coal was crushed to finer sizes. However, the differences were not great enough to make fine grinding a practical means of sulfur reduction for most of the coals tested.
4. The sulfur in the 1.60 specific gravity sink fractions (refuse) for the 40 samples included in this study indicated that five samples had a sulfur content of 20 to 26 percent and might be suitable for processing as a source of sulfur.

3.0 UTILIZATION OF COMPUTER TECHNOLOGY FOR COAL CLEANING:

As stated earlier, the amount, size, shape, and distribution of pyritic sulfur in coal varies from seam to seam and even within a given seam or mine. The degree of pyrite liberation at any given stage of crushing and grinding also varies greatly among coals. If coal is to be effectively cleaned for maximum yield to meet allowable sulfur content regulations imposed by air pollution control agencies, an efficient methodology must be developed for the overall cleaning operation. An ideal situation would be to channel coal with similar pyritic sulfur characteristics to the cleaning equipment which is most suitable for liberating the particular type of pyritic. The cost of such an operation, if conventional methods are used, will be formidable. Utilization of computer technology for data analysis, contour mapping, scheduling, blending, routing

(or channeling) and automation of cleaning processes, could greatly reduce the total cost of sulfur reduction operations.

3.1 EXISTING TECHNOLOGY:

Several computer applications have already been developed. As early as 1962, "computer evaluation of coal preparation washability data" was published by ¹H. B. Chormbury and ¹H. L. Lovell. ²K. K. Humphreys, ²J. W. Leonard, and ²J. A. Buttermore published their work on "Applying Computers to Preparation Problems" in 1969. Westmoreland Coal Company and Clinchfield Coal Company are two typical installations which use computers for coal washability data analysis.

In 1964, Newmont Mining Company and IBM developed computer techniques to rapidly calculate geological information and plot them on contour maps. During the early stages, geologists use the results to update and revise drill test plans. When sufficient drilling has been completed to allow a meaningful computation of one reserve and grade, the mining engineer interfaces with the computer to produce mining plans. Similar techniques could be used to produce contour maps of various levels of natural sulfur content of coal or washability data.

Ferranti Ltd. in Scotland uses electronic equipment to perform on-line control of operations at its four-mine complex. Typical control functions include conveyor operations, particularly for routing coal with different ash content coming from individual mines to an underground coal-blending operation. The utilization of computers for the design, analysis, and operation of rail-haulage systems and for belt-haulage systems have also been reported by a research team at Virginia Polytechnic Institute whose work was done under contract with the Office of Coal Research.

3.2 COMPUTERIZED COAL CLEANING CONCEPT:

An effective coal cleaning operation designed principally for sulfur reduction would require:

- a. A clear knowledge of the coal's washability properties, sulfur content and distribution of the coal within a defined mine or seam. The identification of the variations of coal quality with location, if at all possible, would increase cleaning efficiency.
- b. Matching coal of particular washability property to the cleaning process.
- c. Blending operations to maximize uniformity of cleaned coal.

The computerized coal cleaning process, conceptualized from existing technology can be divided into four phases:

- a. Analysis/Planning Phase
- b. Engineering Phase
- c. Facility Installation Phase
- d. Operation Phase

3.2.1 Analysis/Planning Phase

The major events in the analysis and planning phase of the coal cleaning methodology are illustrated in Table A-3. This phase starts with a geological analysis of the mine or seam to develop a sampling plan, so that the coal samples to be obtained would best represent the coals and identify varying qualities of coal in the mine or seam. This plan could involve face channeling and/or run-of-mine sampling. Then, coal samples will be collected. A portion of each sample of raw coal will go through a chemical analysis to determine its sulfur and ash composition, thermal value, and etc. A large part of each sample will go through float/sink testing. Chemical analysis will then be performed on both the float and the sink fractions to determine the percentage of ash, sulfate, pyrite sulfur, organic sulfur, and total sulfur. All the sample data, and associated boundary and tonnage information which the sample represents will be logged in a computer file.

Computerized data analysis will be performed to identify the yield, percentage of sulfur reduction possible, sulfur content of raw coal and cleaned coal, etc., and association of these data to a geological location. Some statistical analysis can also be performed. The results of these analyses will be used for contour mapping by a computer controlled plotter. The contour map will identify coals of similar cleaning properties and/or sulfur levels.

The computer, through certain analysis, will also identify data gaps which need to be filled. New samples will then be collected and analyzed. In some situations, samples may not be accessible. Then, the needed data may have to wait until mining operations permits the sample to be taken or drill hole samples are obtained. In any event, the computer could log the current status of the mine.

The results obtained from the analyses and contour mapping will be used to develop a coal cleaning plan and also will be important factors to be incorporated into the mining plan. The coal cleaning plan would incorporate at least the following aspects:

- a. Define ranges of raw coal property and categorize according to washability characteristics.
- b. Extrapolate possible geological variations of raw coal property. Rank such extrapolations by confidence factors.
- c. Define the required quality of clean coal.
- d. Select cleaning technique or techniques.
- e. Develop coal handling procedures.
- f. Develop contingency plans to handle coal of qualities extrapolated in (b) above.
- g. Develop budget requirements.

3.2.2 Engineering Phase

After the cleaning properties of the coal field are well established, the coal cleaning facility can then be designed and equipments can be selected. A conceptual computer controlled coal cleaning process is illustrated in Table A-4. Suppose the coal field has been divided into zones 1 to 7. Coal from zones 1, 3, and 4 are found to be similar in cleaning property, or the combination of the coal from those three zones could give the desired clean coal, according to the analysis performed in Phase 1. Coal from those three zones would then be transported to Blender A to be mixed for subsequent crushing and screening operations. The crushing operation would reduce the coal to the desired size for the best sulfur reduction/yield in the cleaning process which is selected according to the analysis results of coal samples representing those three zones.

Similarly, coal from other zones could be blended when desirable and go through crushing, screening, and cleaning operations specifically selected to give the best sulfur reduction/yield for their particular cleaning properties.

The clean coal from each cleaning process may be somewhat different in sulfur content, size, or even BTU value. It may be desirable to blend the clean coal together to obtain uniformity of coal quality.

All the above operations – coal transportation, routing, blending, crushing, screening, cleaning, etc., can be automated with computer control. Of course, the above described operation is quite idealized. The actual situation may not be clear cut. As mining operation progresses, the situation also changes and unknowns will be introduced. The computer will be a valuable tool in such situations, since it can identify problems quickly. It may request the analysis of new coal samples or, it may project solutions by statistical analysis. It can change the routing of coal to a newly selected cleanup process; or it can change the blending operation; all according to a programmed cleaning plan.

¹ Mechanization, April 1962

² Coal Age, February 1969

<u>Process</u>	<u>Organization</u>	<u>Description</u>	<u>Status</u>	<u>Date</u>
SO ₂ removal	Bechtel Corporation & Universal Oil Products	Installations for Commonwealth Edison, Chicago	--	Exp. late 1971
Gasification of coal	Columbia Gas System	--	Research	Exp. late 1970
Gasification of coal	Pittsburgh Energy Res.	Pretreatment for methane, reaction with oxygen and steam	Research and testing plant	Current
Gasification of coal	Columbia Gas System	--	Research	Late 1970
SO ₂ removal	Cleveland Illuminating & Commonwealth Edison	Process dev. by Chemico/Basic, Inc. "Scrubbing" with special chemical agent.	Testing	Late 1971
SO ₂ removal	Babcock & Wilson Co.	Magnesia-base "wet scrubbing" system in boiler flue exhaust - also: Injecting limestone into test furnace and development of dry sorbent.	Demonstration testing	May, 1971
Hydrogasification	Rend Lake, Ina, Illinois	Coal to liquid natural gas	Construction	--
CO Acceptor Gasif.	Consolidation Coal Co.	Lignite & steam. Dolomite for absorption of carbon dioxide.	Testing	--
Coking Coal Gasif.	Bureau of Mines	Continuous stirring of coal	Experimental	--
Coal Hydrogenation	University of Utah	Recycling of gases and hydrogen through reactor	5 yr. contract from OCR	late 1974
Liquification	FMC Project COED	Conversion into char, hydrotreated crude oil, gas, etc.	Research	--

Table A-1 Status of sig Coal Research Project

<u>Process</u>	<u>Organization</u>	<u>Description</u>	<u>Status</u>	<u>Date</u>
Coal to synthetic petroleum	Atlantic Richfield Co. with FMC Corp. and Blaw-Knox Co. "Project Seacoal"	Heating of coal mixed with residuum- condensation of resultant vapors, production of char	Current	--
SO ₂ removal	Boston Edison, NAPCA, Chemical Construction Corp.	Venturi scrubbing system reaction of magnesium oxide to form magnesium sulfite, removal of fly ash	Construction	--
SO ₂ control	NAPCA - Black, Silvalls & Bryson, Inc.	Burning coal inside mass of molten iron - removal of sulfur as solid	Testing	--
Magnetohydrodynamics (MHD)	Mitsubishi Electric Co. Everett Laboratory	Super-high intensity electromagnetic field for generation of super-high DC magnetic field	Accomplished	--
MHD	Avco Everett Res. Lab. Edison Electric Inst.	Power generating system; passing high temp. gas thru magnetic field using fossil fuel combustion	Research	--
SC ₂ removal	Dr. Arthur Squires of City College of New York	Fluidized-bed coal combustion unit - release of sulfur as hydrogen sulfide	Research	--
SO ₂ removal	Eso & Babcock and Wilson	Avoid water poll. as in wet scrubbing; disposition of spent material & avoid high humidity in smoke stacks	R. & D.	1973
SO ₂ removal	NAPCA - TVA	Dry limestone injection process for sulfur removal in stack gases	Study	Mid 1971
SO ₂ removal	Wellmann-Lord	Absorption technique	Demonstration	--

Table A-1 Continued

<u>Process</u>	<u>Organization</u>	<u>Description</u>	<u>Status</u>	<u>Date</u>
SO ₂ removal	Tracor, Inc.	Lab testing of single or mixed oxides, sulfides, carbonates. Addition of metal oxides to flue gases.	Study	--
--	Stanford Res. Inst.	Liquid hydrocarbons & pipeline gas from coal, lignite, tar, sands and oil shale.	R. & D.	1975-1985
--	Humble Oil Co.	Coal into liquid hydrocarbons	R. & D.	--
SO ₂ removal	Combustion Efficiency Corporation	Fuel burning system - conversion of liquid fuel (pulverized coal) to gas prior to ignition	Testing	Current
SO ₂ removal	TVA	Ammonia solution wet scrubbing process	Testing	--
SO ₂ removal	Consolidation Coal with Dr. Everett Gorin, Dr. Paul Yavorsky and Nestor J. Mazzocco	Scrubbing with potassium formate to produce thiosulfate to react with addl. formate to yield potassium hydrosulfide for stripping with carbon dioxide & steam	Demonstration	--

Table A-1 Continued

EFFECT OF COAL SIZE ON SULFUR REDUCTION *

Recovery (%)	Total sulfur (%)			Pyritic sulfur (%)		
	1 1/2" x 0	3/8" x 14 mesh	14 x 100 mesh	1 1/2" x 0	3/8" x 14 mesh	14 x 100 mesh
40	2.35	2.33	2.24	0.55	0.52	0.39
50	2.43	2.40	2.33	0.62	0.58	0.48
60	2.54	2.48	2.46	0.73	0.68	0.61
70	2.69	2.60	2.60	0.89	0.81	0.78
80	2.87	2.75	2.78	1.09	0.97	0.99

* Sulfur values are given on the dry basis and are averages of 40 samples.
From U.S. Bureau of Mines

TABLE A-2

INTRODUCTION
to the
COAL RESOURCES AND RESERVES INVENTORY

The objective of the Coal Resources Inventory is to identify coal reserves in Illinois, Indiana and Kentucky and specifically minable low-sulfur coals. The identification of low-sulfur coal reserves will provide a basis for economic analyses to determine the feasibility of using these coal resources to reduce air pollution.

The Federal Systems Division of the IBM Corporation, under contract with the State of Illinois, Department of Public Health, is responsible for the conduct of a study to determine Considerations of Making Low-Sulfur Coal Available for Air Pollution Control. This study is of concern to the Midwest Coal Producers Institute, Inc., coal producers throughout the Midwest Basin, industrial users, allied transportation industries, and state and federal air pollution control authorities and agencies.

Essential to the performance of this study is the collection of a comprehensive compendium of coal data for all minable reserves regardless of sulfur content throughout the Midwest Basin. At the present time, coal resources and reserves information are highly fragmented. Data from numerous organizations such as the Midwest Coal Producers Institute, Inc., Tennessee Valley Authority, the Illinois, Kentucky, and Indiana departments of Mines and Minerals, State and Federal geological surveys, and private mining companies must be collected to provide a meaningful picture of the reserves available.

The Coal Resources and Reserves Inventory will serve as a means of compiling information essential to the study. The success of this study is contingent upon the support and cooperation of all companies and agencies who can and will make data pertaining to coal resources and reserves available. Data obtained from private companies will be held confidential and security procedures will be maintained. Access to the data bank will be on a "need to know basis" within IBM, and will be released only with permission of the companies concerned. General area-wide statistics, the final report and coal quality maps on the geographical location of coal reserves, quantities and quality will be made available through the Illinois Department of Public Health and the Midwest Coal Producers Institute, Inc. on completion of the study.

COAL RESOURCES AND RESERVES INVENTORY
GENERAL INSTRUCTIONS

The reporting company should identify all coal resources and reserves upon which it has accumulated data. In instances where there are historical or overlapping records, the most reliable or latest available information should be reported at the discretion of the company.

The following general rules should be adhered to in preparing the inventory forms:

- (a) Minal coal resources which are contiguous to an established operational mine should be reported under the identification number assigned to the mine.
- (b) Minal coal reserves which are non-contiguous or which are to be recovered through a to-be-established operational complex should be reported under the identification number assigned to the company.
- (c) Minal coal reserves at closed or abandoned mines should be reported under the company identification number.
- (d) All resources/reserves data must be reported by seam identification number and by geographical location.
- (e) Geographical locations should be specified in terms of township/range and section for Illinois and Indiana mines.
- (f) Geographical locations for mines in Kentucky should be specified in terms of the Carter Grid System.
- (g) If a company (or mine) has contiguous reserves which cover an entire township/range, and if the underlying coal is of a uniform quality (e. g. ± 0.1 percent total sulfur content), the data for all sections may be summarized and only one inventory sheet filled out.
- (h) If multiple sets of valid analytical data are available for a particular seam and location, a representative set of data should be selected or a mean average calculated for each item.
- (i) All numeric data should be right-justified in the allotted field and preceded with zeros as required to fill the field. (For example: if the number 123 is to be written in a field comprised of five positions, it should be written as 00123).
- (j) The form provides for the input of four classes of data: identification, quantity, quality, and annual production. If a particular class of data is not available, or not applicable, draw a red line through the class.

Following are detailed instructions for the completion of the Coal Resources and Reserves Inventory. For ease in identification, each field is represented pictorially. The information for each seam and geographical location will require one page for the reporting of the requested information. If data is not available or applicable for a particular item of information, leave the space blank.

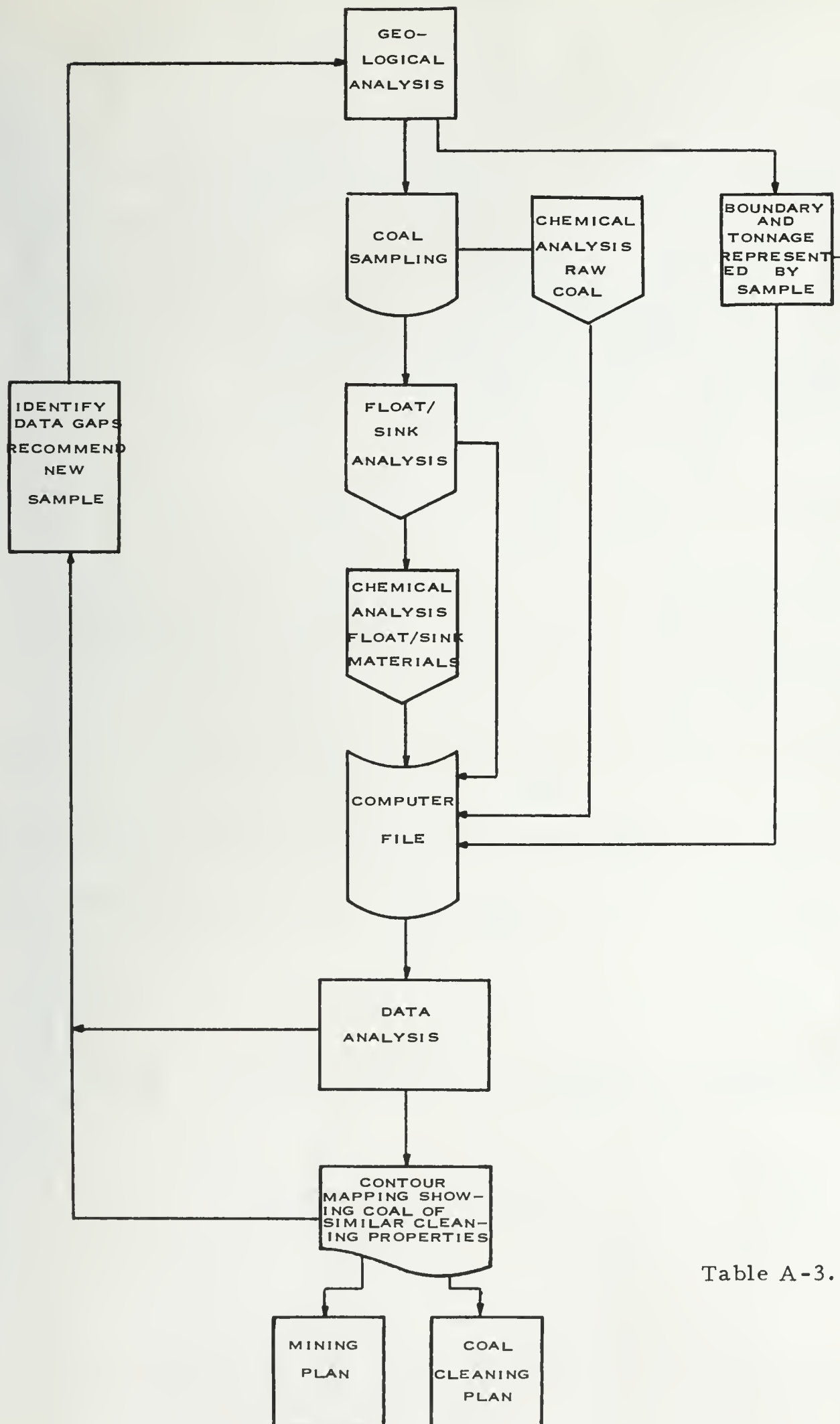


Table A-3.

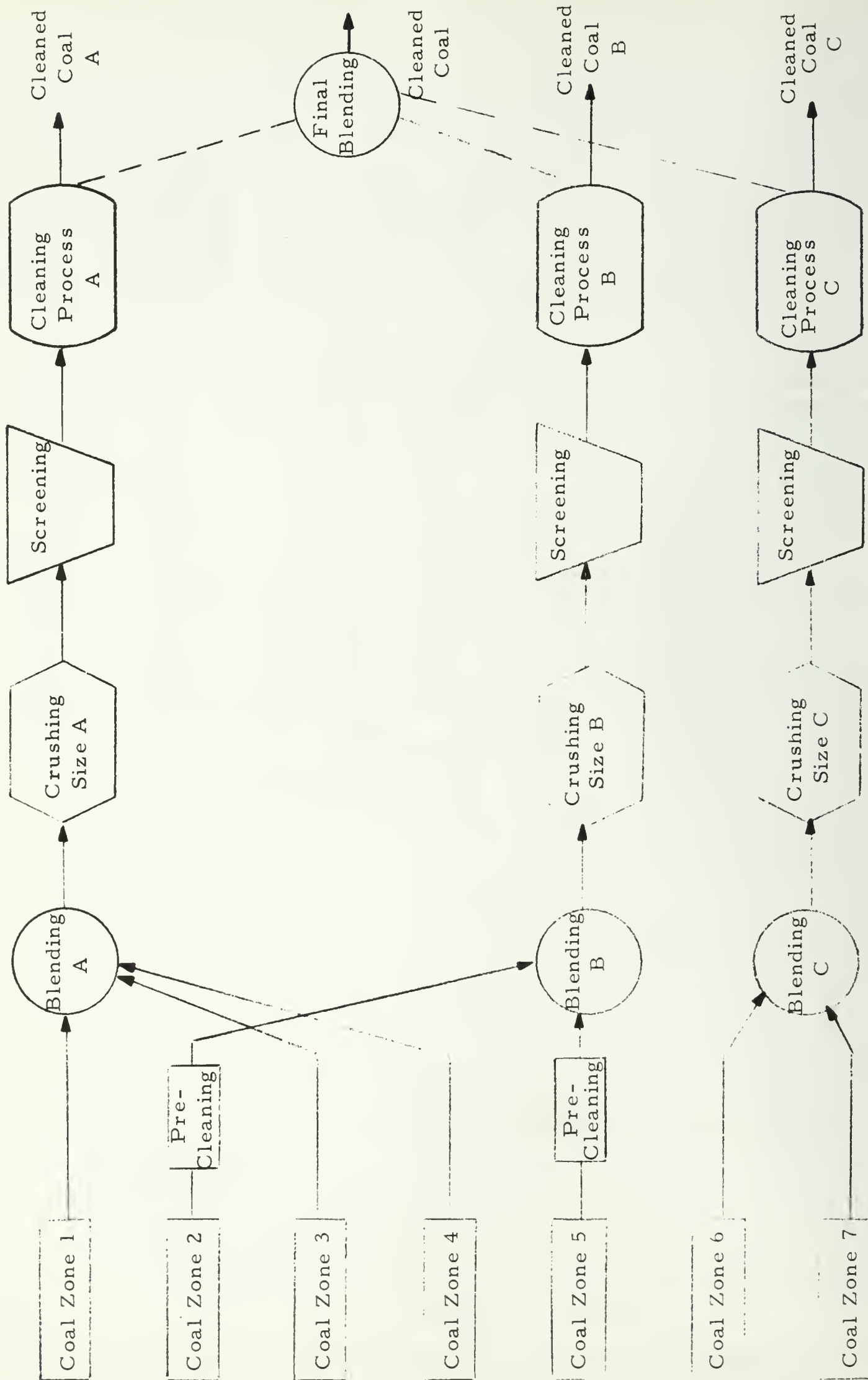
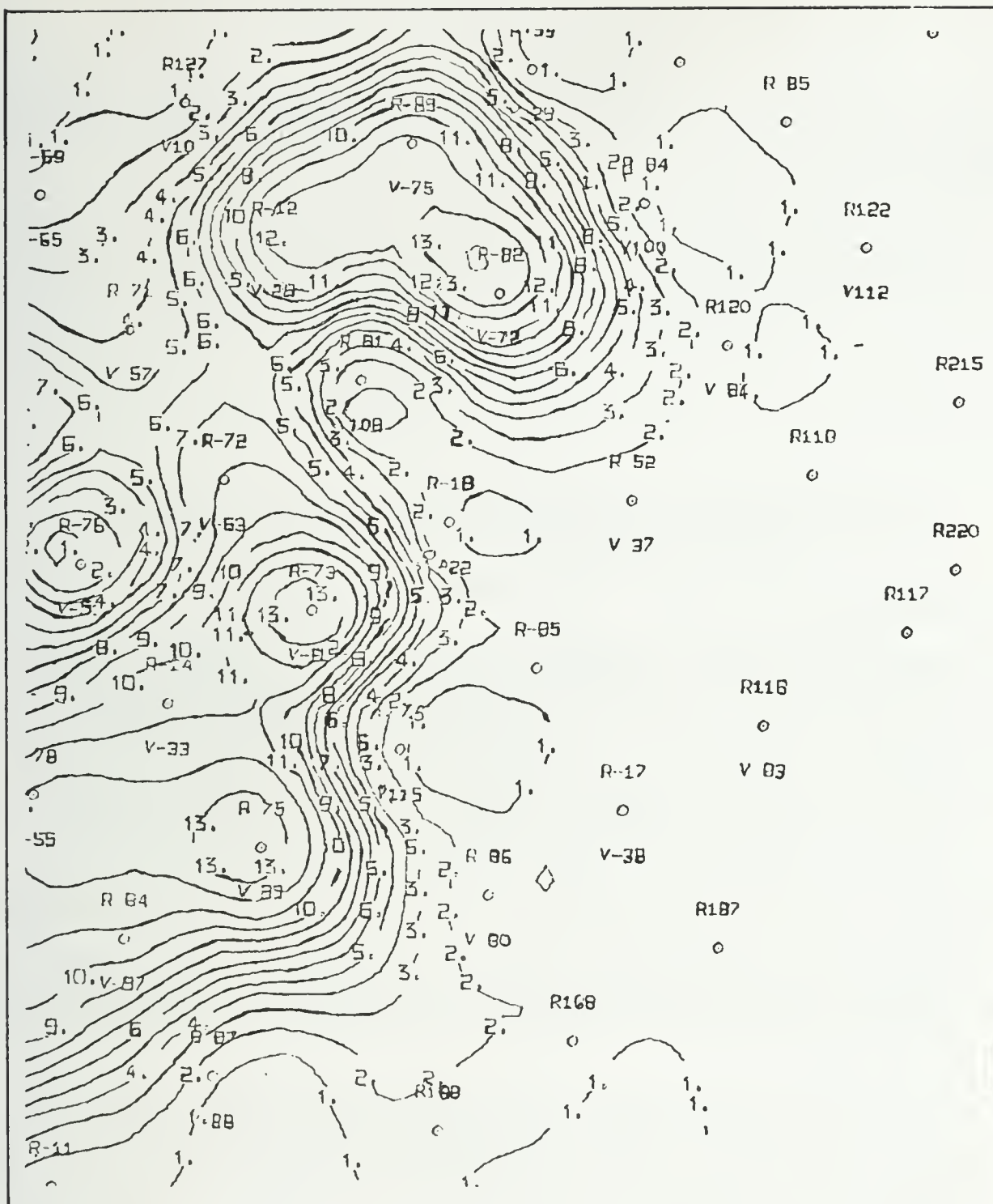


Table A-4.

CONCEPTUAL COMPUTERIZED COAL CLEANING PROCESS



MID-WEST COAL PRODUCERS INSTITUTE, INC.

307 NORTH MICHIGAN AVENUE

CHICAGO, ILLINOIS 60601

TELEPHONE FINANCIAL 6-7447

OTIS J. GIBSON

EXECUTIVE VICE PRESIDENT

July 11, 1969

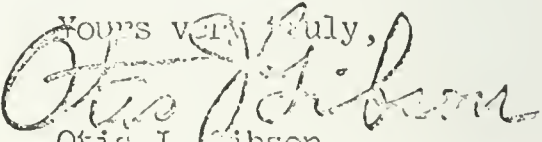
To Coal Operators in Illinois, Indiana and West Kentucky

Gentlemen:

Mid-West Coal and the Federal Government are jointly funding a survey of the mineable low-sulfur coal reserves in the Midwest basin, with a view toward subsequently undertaking an economic analysis of the feasibility of making low-sulfur coal available for air pollution control purposes. The Federal Systems Division of IBM Corporation, under contract to the Illinois Department of Public Health, will be responsible for the study's implementation.

This study is considered to be of critical importance to all coal operators in our air pollution requirements. During the course of the study I will serve as a member of its Advisory Committee.

Essential to the success of this study is the generation of a comprehensive coal resources data bank incorporating coal quality and reserve data throughout the Midwest basin. It would be most helpful to the study if your company would cooperate by completing the attached preliminary questionnaire. Data obtained will be maintained in confidence and its controlled distribution is assured. Your prompt attention to the attached questions will be most appreciated.

Yours very truly,

Otis J. Gibson
Executive Vice President

OJG:fr

Attachment

PLEASE TYPE OR PRINT AND
RETURN BEFORE JULY 25, 1969

STATES OF ILLINOIS, INDIANA, KENTUCKY

COAL STUDY SURVEY

Your cooperation in providing the following information will be appreciated. Questions may be directed to Mr. Otis Gibson, Midwest Coal Producers Institute, Inc., 307 North Michigan Avenue, Chicago, Illinois, 60601. Telephone: 312-346-7447.

Company Name: _____

Representative: _____

Phone No: _____

1. PLEASE CONFIRM DATA ON ATTACHMENT NO. 1 FOR MWCPI RECORDS.

PLEASE TYPE OR PRINT

Company Name: _____

2. The success of this study depends upon release of coal producer geological and mine sample quality data, e.g., sulfur content, ash content, seam thickness, etc., by geographical location, specifically Township, Range and Section, for Illinois and Indiana - or Carter Grid coordinates for Kentucky.

- a. Will company maps be made available which show coal quality by seam?

YES _____
NO _____

- b. If NO, please indicate under what conditions such data might be made available;

- c. Please estimate data available by seam and location, i.e., total number of records available:

- d. Can data transfer be made by your staff from your files to a study-approved format?

YES _____
NO _____

- e. If NO, please make alternate suggestions:

MID-WEST COAL PRODUCERS INSTITUTE, INC.

307 NORTH MICHIGAN AVENUE

CHICAGO, ILLINOIS 60601

TELEPHONE FINANCIAL 6-7447

OTIS J. GIBSON

EXECUTIVE VICE PRESIDENT

Oct. 24, 1969

To Coal Operators in Illinois, Indiana and West Kentucky

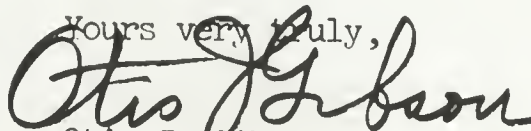
Gentlemen:

Mid-West Coal and the Federal Government are jointly funding a survey of the mineable low-sulfur coal reserves in the Midwest basin, with a view toward subsequently undertaking an economic analysis of the feasibility of making low-sulfur coal available for air pollution control purposes. The Federal Systems Division of IBM Corporation, under contract to the Illinois Department of Public Health, will be responsible for the study's implementation.

This study is considered to be of critical importance to all coal operators in our air pollution requirements. During the course of the study I will serve as a member of its Advisory Committee.

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Yours very truly,



Otis J. Gibson

Executive Vice President

OJG:fr

Attachment

ILLINOIS COAL STUDY QUESTIONNAIRE

Company Name: _____

- [illegible]

— 250 —

Company Name: _____

2. Please provide county information on quality of reserves by seam, whether or not reserves are being mined at present.

County	Seam Name and/or No.	Total Reserves regardless of sulfur level (thous. tons)	Percentage of total sulfur					
			1 or less	1.1 to 2	2.1 to 3	3.1 to 4	4.1 to 5	Over 5

3. Estimate reserves in 2% or less categories (as indicated above) dedicated to:

Utilities _____%

Coke & Steel Industries _____%

Other Industries _____%

Retail Sales _____%

Export _____%

Use at Mine _____%

4. If any low sulfur (less than 2%) reserves are not dedicated, are they available for utilities? Please comment.

COAL RESOURCES & RESERVES INVENTORY

C	R	1	2	3

COMPANY CONFIDENTIAL (CHECK)	DATE LATEST INFORMATION
YES	NO
74	74

COUNTY NAME:		COUNTY NAME:	
SOURCE IDENT	STATE (CHECK)	COUNTY (CODE)	LOCATION
3/4/5	IL, KY, IN.		
6	7	8	9
10	11	12	13
14	15	16	17
18	19	20	21
22	23	24	25
26	27	28	29
30	31	32	33
34	35	36	37
38	39	40	41
42	43	44	45
46	47	48	49
50	51	52	53
54	55	56	57
60	61	62	63
64	65	66	67
68	69	70	71
72	73	74	75
76	77	78	79
80	81	82	83
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1116	1117		

DETAILED INSTRUCTIONS

COMPANY CONFIDENTIAL (CHECK)	
YES 74	NO 74

Check the appropriate space to indicate whether or not the data being provided upon this specific page is to be considered company confidential and is to be processed in accordance with established security procedure.

DATE OF LATEST INFORMATION MO. / DAY / YR.					
75	76	77	78	79	80

Enter the date of the latest available information which is being reported for the specified seam and designated location. All data provided will be assumed to be current and valid as of the specified date. Enter the numeric equivalent for the month (01-12) in the first two positions. Enter the day of the month in the second two positions and precede with zero if required. Enter the last two digits of the year in the fifth and sixth positions. For example: January 3, 1969 would be entered as 010369.

SOURCE NAME:

Enter the name of the company or mine which is reporting the identified resource or reserve.

COUNTY NAME:

Enter the name of the county in which the identified resource or reserve is located.

SOURCE IDENT						
6	7	8	9	10	11	

Enter the source identification number corresponding to the source name. The source number will identify a company or a specific mine. The numbers to be used may be obtained from a list previously provided. If an identification number has not been previously assigned, leave the field blank.

STATE (CHECK)		
IL.	KY.	IN.
12 13	12 13	12 13

Place a check mark in the space containing the abbreviation of the state in which the identified resource is located. Check only one. (IL=Illinois, KY=Kentucky, and IN=Indiana.)

COUNTY (CODE)		
14	15	16

Enter the code designation for the county name specified on the line above. This code identifies the county in which the identified resource is located. The county codes to be used are listed on pages for Illinois, pages for Kentucky and pages for Indiana.

LOCATION 1									
17	18	19	20	21	22	23	24	25	26

Enter the geographical location of the resource or reserve. The location is to be identified in accordance with either the Rectangular Survey or the Carter Grid System. The Rectangular Survey System will be used in identifying locations in Illinois and Indiana. The location will be comprised of the following elements from left to right:

- a. Base line - a one digit code identifying the latitudinal reference point. Base lines are identified on the sample maps contained on pages 19-20.
- b. Principal Meridian - a one digit code identifying the longitudinal reference point. Principal meridians are identified on the sample maps contained on pages 19-20.
- c. Township - a two digit, one character code identifying the vertical location of the area, relative to the specified base line and principal meridian. The character will be N (North) or S (South), indicating the direction from the base line.
- d. Range - a two digit, one character code identifying the horizontal location of the area relative to the specified base line and principal meridian. The character will be E (East) or W (West), indicating the direction from the principal meridian.
- e. Section - a two digit code identifying the specific one square mile area within the identified township and range. If the section number is not available, zeros should be entered.

An example of the Rectangular Survey System Location code follows:

1	3	10N	02W	16
				Section Number
				Range Identification
				Township Identification
				Principal Meridian
				Base Line Code

NOTE: Leading zeros must preface any one digit township or range number.

MINING METHOD (CODE)
30

Enter the appropriate code from the following list:

<u>Code</u>	<u>Mining Method</u>
A	Auger
S	Strip
U	Underground

TYPE RESERVE ESTIMATE (CODE)
31

Enter the appropriate code from the following list:

<u>Code</u>	<u>Type Reserve Estimate</u>
M	Measured, see following definition
D	Indicated, see following definition
F	Inferred, see following definition.

Measured Reserves

Measured reserves are reserves for which tonnage is computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of the coal are so well defined that the computed tonnage is judged to be accurate within 20 percent of the true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of coal varies in different regions according to the character of the coalbeds, the points of observation are, in general, about half a mile apart.

Indicated Reserves

Indicated reserves are reserves for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are about 1 mile apart, but they may be as much as 1-1/2 miles apart for beds of known continuity.

Inferred Reserves

Inferred reserves are reserves for which quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and for which few measurements of bed thickness are available. The estimates are based on an assumed continuity for which there is geologic evidence. In general, inferred coal lies more than 2 miles from the outcrop or from points of mining or drill hole information.

QUANTITY AVAILABLE (THOUS. TONS)					
32	33	34	35	36	37

Enter the estimated number of thousands of tons of raw coal available from the specified seam at the designated location. Enter the numbers right-justified and preceded by zeros. For example: 5,000,000 (five million) tons would be entered as 005000.

QUANTITY RECOVERABLE (THOUS. TONS)					
38	39	40	41	42	43

Enter the estimated number of thousands of tons of raw coal which may be recovered from the specified seam at the designated location. Enter the numbers right-justified and preceded by zeros. For example: 3,500,000 (3.5 million) tons would be entered as 003500. If accurate data is not available, please enter fifty percent of QUANTITY AVAILABLE.

QUANTITY DEDICATED (THOUS. TONS)					
44	45	46	47	48	49

Enter the number of thousands of tons of raw coal which has been previously dedicated to consumers from the specified seam at the designated location. Enter the numbers right-justified and preceded by zeros. For example: 2,000,000 (2 million) tons would be entered as 002000.

If the data being reported is pertinent to an operational mine and the designated seam and location, the reported values for QUANTITY AVAILABLE, QUANTITY RECOVERABLE, and QUANTITY DEDICATED should be adjusted to reflect the quantities as of January 1, 1970.

PCT. UTILITIES	
50	51

Enter the percentage of the QUANTITY DEDICATED which is dedicated for utilities. Enter the number right-justified and preceded by zeros. For example: 80 per cent would be entered as 080.

PCT. COKE/ STEEL	
53	54

Enter the percentage of the QUANTITY DEDICATED which is dedicated for coke and steel industries. Enter the number right-justified and preceded by zeros. For example: 5 percent would be entered as 005.

PCT. INDUSTRIAL			
56	57	58	

Enter the percentage of the QUANTITY DEDICATED which is dedicated for other industrial processes (other than coke or steel). Enter the number right-justified and preceded by zeros. For example: 50 per cent would be entered as 050.

PCT. RETAIL			
59	60	61	

Enter the percentages of the QUANTITY DEDICATED which is dedicated to retail sales. Enter the number right-justified and preceded by zeros. For example: 5 per cent would be entered as 005.

PCT. FOREIGN EXPORT			
62	63	64	

Enter the percentage of the QUANTITY DEDICATED which is dedicated for export to foreign countries. Enter the number right-justified and preceded by zeros. For example: 7 per cent would be entered as 007.

START DATE MO./YR.			
65	66	67	68

Enter the month and year in which the coal resources or reserves identified will be mined or upon which mining began. The date will be comprised of month and year, two digits each. Months are to be numbered 01 through 12 and entered in the first two positions. The last two digits of the year (e. g. 69 for 1969) are to be entered in the third and fourth positions of the field.

END DATE MO./YR.			
69	70	71	72

Enter the month and year in which the minable coal resources or reserves are expected to be exhausted. The date will be comprised of month and year, two digits each. Months are to be numbered 01 through 12 and entered in the first two positions. The last two digits of the year (e. g., 70 for 1970) are to be entered in the third and fourth positions of the field.

SEAM THICKNESS (INCHES)		
29	30	31

Enter the average thickness of the specified seam at the designated location in inches. Numbers are to be right-justified and preceded with zeros. For example: eight inches would be entered as 008. Minimum thickness of reserves which will be considered minable will be 18 inches.

DEPTH OVERBURDEN (FEET)			
32	33	34	35

Enter the average number of feet of overburden for the specified seam at the designated location. Enter the numbers right-justified and preceded by zeros. For example: eighty feet would be entered as 0080.

ANALYSIS SOURCE (CODE)	
36	

Enter the appropriate code from the following list of descriptive analysis sources:

<u>Code</u>	<u>Analysis Source</u>
1	Company records
2	United States Geological Survey
3	United States Bureau of Mines
4	Illinois Geological Survey
5	Indiana Geological Survey
6	Kentucky Geological Survey
7	Tennessee Valley Authority
8	Other

SAMPLE TYPE (CODE)	
37	

Enter the code from the list below to appropriately describe the type of coal sample upon which the qualitative analysis was performed.

<u>Code</u>	<u>Description</u>
C	Core (drill hole)
F	Face sample or outcrop
R	Run-of-the-Mine
U	Uncleaned Tipple
Blank	Unknown

HEATING VALUE (BTU/LB.)				
38	39	40	41	42

Enter the average heating value of one pound of coal expressed in British Thermal Units (BTU's). Enter the number right-justified and preceded by zeros. For example: 1745 would be entered as 01745

ASH CONTENT (PERCENT)		
43	44	45

Enter the average percent of ash content of the coal expressed to the nearest tenth of a percent. Enter the decimal fraction in the right-most position. Enter whole numbers in the first and second positions and precede with zeros. For example: 8 percent would be entered as 080.

TOTAL SULFUR (PERCENT)		
46	47	48

Enter the percent of total sulfur content of the coal expressed to the nearest tenth of a percent. Enter the decimal fraction in the right-most position. Enter whole numbers in the first and second positions and precede with zeros. For example: 4.25 per cent would be entered as 043.

PYRITIC SULFUR (PERCENT)		
49	50	51

Enter the percent of pyritic sulfur content of the coal expressed to the nearest tenth of a percent. Enter the decimal fraction in the right-most position. Enter whole numbers in the first and second positions and precede with zeros. For example: 11 percent would be entered as 110.

ORGANIC SULFUR (PERCENT)		
52	53	54

Enter the percent of organic sulfur content of the coal expressed to the nearest tenth of a percent. Enter the decimal fraction in the right-most position. Enter whole numbers in the first and second positions and precede with zeros. For example: 4.62 per cent would be entered as 046.

NOTE: If any two of the three percentages of sulfur content are available, the data abstractor should calculate the third and enter it. If only TOTAL SULFUR is available, PYRITIC SULFUR and ORGANIC SULFUR should be left blank.

CLEANED QUALITY (PERCENT)		
55	56	57

Enter the percentage of total sulfur content of the finished coal shipped from the mine, expressed to the nearest tenth of a percent. Enter the decimal fraction in the right-most position. Enter whole numbers in the first and second positions and precede with zeros. For example, 2.9 percent would be entered as 029.

Coal production data, historical and projected, are to be entered for all locations and seams upon which data is available. If mining operations have been ongoing at a specified seam and designated location since 1968, data should be provided for each year to date and projected for 1969, 1970 and 1971. If the seam and locations specified identifies a company reserve or mine resource, the projected production in future years should be specified, if planned. For example: if a company plans to establish an operational mining complex at a specified seam and location in 1970 and plans to recover the coal over a five-year period, projected production levels for 1970, 1971, 1972, 1973 and 1974 should be provided.

Space is provided on the collection form for the designation of four years of production data. Production years should be designated from left to right in ascending sequential order. If additional space is required, staple another form to the one being completed and continue to fill in production years and quantity data.

PRODUCTION YEAR	
29	30

Enter the last two digits of the year to identify the year pertinent to the following historical or projected production data.

RAW QUANTITY (THOUS. TONS)				
31	32	33	34	35

Enter the number of thousands of tons of raw coal recovered from the specified seam and designated location. Enter the number right-justified and preceded by zeros. For example: 3,560,000 tons would be entered as 03560.

SHIPPED QUANTITY (THOUS. TONS)				
36	37	38	39	40

Enter the number of thousands of tons of coal shipped from the specified seam and designated location. Enter the numbers right-justified and preceded by zeros. For example: 102,200 tons would be entered as 00102.

CLEANED QUANTITY (THOUS. TONS)				
41	42	43	44	45

Enter the thousands of tons of mechanically cleaned coal shipped from the specified seam and designated location. Enter the numbers right-justified and preceded by zeros. For example: 365,900 tons would be entered as 00366.

NOTE: The quantity shipped should include any quantities consumed at a "mine-mouth" generation. (This is necessary to reflect total production.)

COAL RESOURCES

RESERVES INVENTORY

COMPANY IDENTIFICATION (CHECK)	
YES	NO

DATE OF LATEST INFORMATION	
MO./DAY/YR.	MO./DAY/YR.

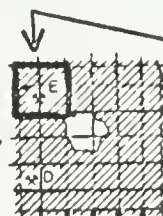
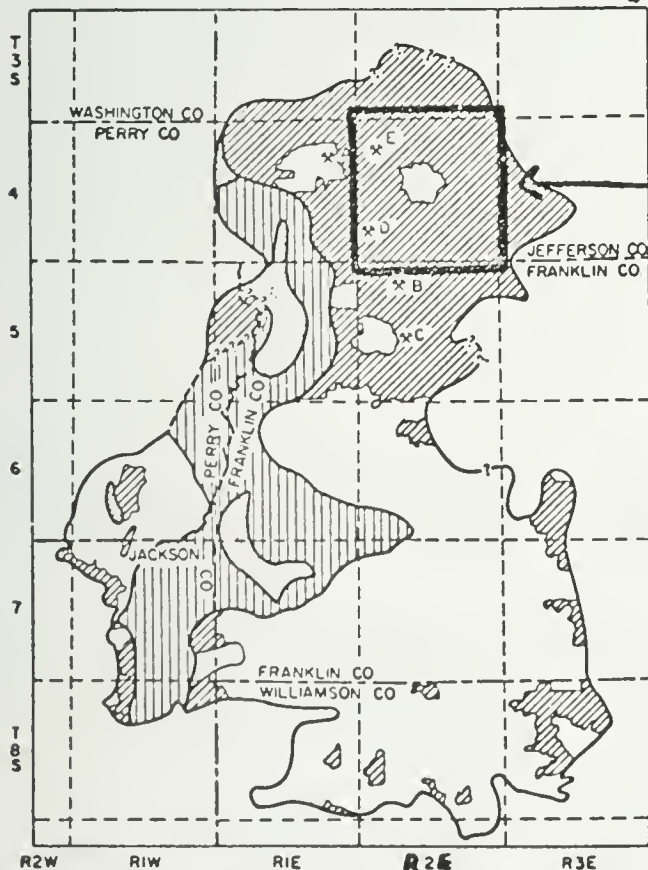
SOURCE NAME: Mine "E", ABC Mining Corp		COUNTY NAME: Jefferson	
SOURCE IDENT.	STATE (CHECK)	COUNTY (CODE)	LOCATION
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288	289	290	291
289	290	291	29

EXAMPLE OF RESOURCE LOCATION CODING

Code for third principal meridian is 3

Code for Baseline is 2

The examples below illustrate the coding of resource locations reported by Mine "E" for four sections (5, 6, 7, 8) within Township #4 South, Range #2 East which is in Jefferson County, Illinois.



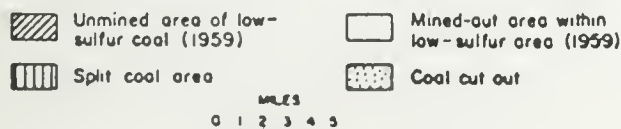
Section Numbering System Within a Township

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

Resource Location

2	3	Ø	4	S	Ø	2	E	Ø	5
2	3	Ø	4	S	Ø	2	E	Ø	6
2	3	Ø	4	S	Ø	2	E	Ø	7
2	3	Ø	4	S	Ø	2	E	Ø	8

Principal Meridian
 Baseline
 Township
 Range
 Section



LIST OF ILLINOIS COUNTIES AND COUNTY CODES

CODE	COUNTY	CODE	COUNTY
001.....	Adams	103.....	Lee
003.....	Alexander	105.....	Livingston
005.....	Bond	107.....	Logan
007.....	Boone	109.....	McDonough
009.....	Brown	111.....	McHenry
011.....	Bureau	113.....	McLean
013.....	Calhoun	115.....	Macon
015.....	Carroll	117.....	Macoupin
017.....	Cass	119.....	Madison
019.....	Champaign	121.....	Marion
021.....	Christian	123.....	Marshall
023.....	Clark	125.....	Mason
025.....	Clay	127.....	Massac
027.....	Clinton	129.....	Menard
029.....	Coles	131.....	Mercer
031.....	Cook	133.....	Monroe
033.....	Crawford	135.....	Montgomery
035.....	Cumberland	137.....	Morgan
037.....	DeKalb	139.....	Moultrie
039.....	DeWitt	141.....	Ogle
041.....	Douglas	143.....	Peoria
043.....	DuPage	145.....	Perry
045.....	Edgar	147.....	Piatt
047.....	Edwards	149.....	Pike
049.....	Effingham	151.....	Pope
051.....	Fayette	153.....	Pulaski
053.....	Ford	155.....	Putnam
055.....	Franklin	157.....	Randolph
057.....	Fulton	159.....	Richland
059.....	Gallatin	161.....	Rock Island
061.....	Greene	163.....	St. Clair
063.....	Grundy	165.....	Saline
065.....	Hamilton	167.....	Sangamon
067.....	Hancock	169.....	Schuyler
069.....	Hardin	171.....	Scott
071.....	Henderson	173.....	Shelby
073.....	Henry	175.....	Stark
075.....	Iroquois	177.....	Stephenson
077.....	Jackson	179.....	Tazewell
079.....	Jasper	181.....	Union
081.....	Jefferson	183.....	Vermilion
083.....	Jersey	185.....	Wabash
085.....	JoDavies	187.....	Warren
087.....	Johnson	189.....	Washington
089.....	Kane	191.....	Wayne
091.....	Kankakee	193.....	White
093.....	Kendall	195.....	Whiteside
095.....	Knox	197.....	Will
097.....	Lake	199.....	Williamson
099.....	LaSalle	201.....	Winnebago
101.....	Lawrence	203.....	Woodford

LIST OF INDIANA COUNTIES AND COUNTY CODES

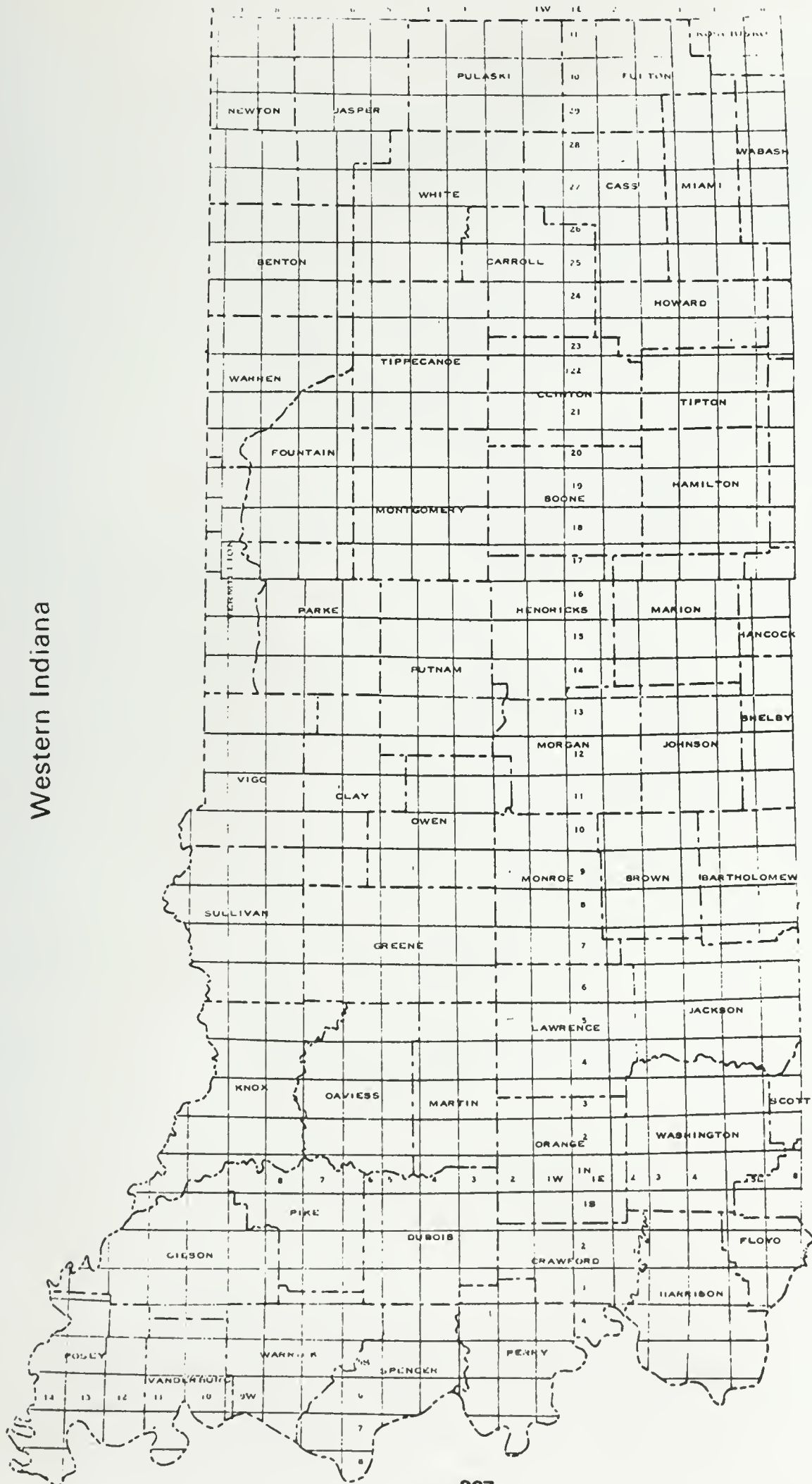
CODE	COUNTY	CODE	COUNTY
001.....	Adams	093.....	Lawrence
003.....	Allen	095.....	Madison
005.....	Bartholomew	097.....	Marion
007.....	Benton	099.....	Marshall
009.....	Blackford	101.....	Martin
011.....	Boone	103.....	Miami
013.....	Brown	105.....	Monroe
015.....	Carroll	107.....	Montgomery
017.....	Cass	109.....	Morgan
019.....	Clark	111.....	Newton
021.....	Clay	113.....	Noble
023.....	Clinton	115.....	Ohio
025.....	Crawford	117.....	Orange
027.....	Daviess	119.....	Owen
029.....	Dearborn	121.....	Parke
031.....	Decatur	123.....	Perry
033.....	DeKalb	125.....	Pike
035.....	Delaware	127.....	Porter
037.....	Dubois	129.....	Posey
039.....	Elkhart	131.....	Pulaski
041.....	Fayette	133.....	Putnam
043.....	Floyd	135.....	Randolph
045.....	Fountain	137.....	Ripley
047.....	Franklin	139.....	Rush
049.....	Fulton	141.....	St. Joseph
051.....	Gibson	143.....	Scott
053.....	Grant	145.....	Shelby
055.....	Greene	147.....	Spencer
057.....	Hamilton	149.....	Starke
059.....	Hancock	151.....	Steuben
061.....	Harrison	153.....	Sullivan
063.....	Hendricks	155.....	Switzerland
065.....	Henry	157.....	Tippecande
067.....	Howard	159.....	Tipton
069.....	Huntington	161.....	Union
071.....	Jackson	163.....	Vanderburgh
073.....	Jasper	165.....	Vermilion
075.....	Jay	167.....	Vigo
077.....	Jefferson	169.....	Wabash
079.....	Jennings	171.....	Warren
081.....	Johnson	173.....	Warrick
083.....	Knox	175.....	Washington
085.....	Kosciusko	177.....	Wayne
087.....	LaGrange	179.....	Wells
089.....	Lake	181.....	White
091.....	LaPorte	183.....	Whitley

LIST OF WEST KENTUCKY COUNTIES
AND COUNTY CODES

CODE	COUNTY	CODE	COUNTY	CODE	COUNTY	CODE	COUNTY
003.....	Allen	105.....	Hickman	055.....	Crittenden	163.....	Meade
007.....	Ballard	107.....	Hopkins	059.....	Daviess	177.....	Muhlenberg
009.....	Barren	111.....	Jefferson	061.....	Edmonson	183.....	Ohio
027.....	Breckinridge	123.....	Larue	075.....	Fulton	213.....	Simpson
029.....	Bullitt	139.....	Livingston	083.....	Graves	219.....	Todd
031.....	Butler	141.....	Logan	085.....	Grayson	221.....	Trigg
033.....	Caldwell	143.....	Lyon	091.....	Hancock	225.....	Union
035.....	Calloway	145.....	McCracken	093.....	Hardin	227.....	Warren
039.....	Carlisle	149.....	McLean	099.....	Hart	233.....	Webster
047.....	Christian	157.....	Marshall	101.....	Henderson		

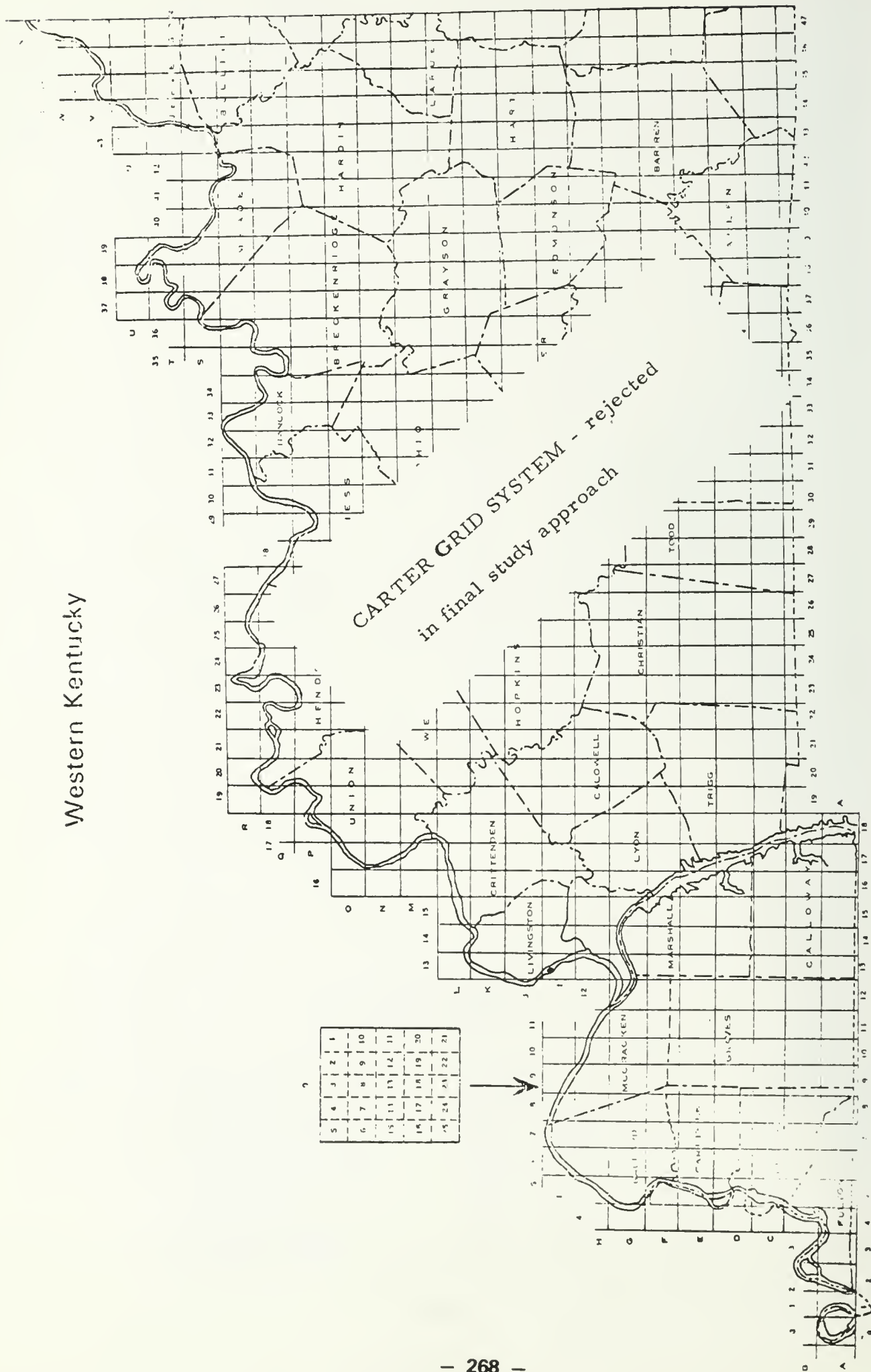
Western Indiana

Western Indiana



Western Kentucky

Western Kentucky



ALPHABETIC INDEX TO DETAILED INSTRUCTIONS

<u>PAGE</u>	<u>FIELD NAME</u>
10.....	Analysis Source
11.....	Ash Content
12.....	Cleaned Quality
13.....	Cleaned Quantity
4.....	Company Confidential
5.....	County (Code)
4.....	County Name
4.....	Date of Latest Information
10.....	Depth Overburden
9.....	End Date
11.....	Heating Value
5.....	Location
7.....	Mining Method
11.....	Organic Sulfur
8.....	Percent (PCT.) Cake/Steel
9.....	Percent (PCT.) Foreign Export
9.....	Percent (PCT.) Industrial
9.....	Percent (PCT.) Retail
8.....	Percent (PCT.) Utilities
12.....	Production Year
11.....	Pyritic Sulfur
8.....	Quantity Available
8.....	Quantity Dedicated
8.....	Quantity Recoverable
12.....	Raw Quantity
10.....	Sample Type
6.....	Seam Ident
6.....	Seam Status
10.....	Seam Thickness
13.....	Shipped Quantity
4.....	Source Ident
4.....	Source Name
9.....	Start Date
4.....	State
11.....	Total Sulfur
7.....	Type Reserve Estimate

ILLINOIS COAL STUDY

Summary Of Questionnaire II Returns

Name of Company	Q. ret'd.	Not ret'd.	Remarks	Name of Company	Q. ret'd.	Not ret'd.	Remarks
A. & T. Coal Co.		X		Morris Bros. Coal Co.		X	
Arel Coal Sales Inc.		X		Morris Enterprises Co.		X	
Ayrshire Collieries		X		Maseley Coal Co.		X	
Badgett Mine Stripping Co.		X		Mt. Pleasant Mining Co.		X	
Basin Cream Coal Co.			Out of business	Mulzer Bros. Coal Co.		X	
B. B. Mining Co.		X		Old Ben Coal Co.	X		
Barbara Kay Coal Co.		X		P. & D. Coal Co.		X	
Bell & Zaller	X			Parke Coal Co.		X	
Belle Valley Coal Co.		X		Parton Coal Co.		X	
Big Bear Coal Co.			Out of business	Peabody Coal Co.	X		
Black Tam Mining Co.	X			Pine Valley Coal Co.		X	
Boehmann Bros.		X		Pittsburgh & Midway Coal Co.	X		
Boone Coal Co.		X		Pyro Mining Co. Inc.	X		
Bowling Coal Co.		X		R. & H. Mining Co. Inc.		X	
Brown & Walker Coal Co.		X		R. & L. Trucking Co.		X	
Bunny Coal Co.		X		R. S. & K. Coal Corp.		X	
Burcham Bros. Coal Co.		X		Rialto Coal Co.	X		
Burge Coal Co.		X		Roberts Bros. Coal Co.		X	
C. & H. Coal Co.		X		Russell Badgett Jr. Coal Co.		X	
C. & S. Coal Corp.		X		Sahara Coal Co.	X		
Caney Creek Coal Co.		X		S. & A. Coal Co.		X	
Chesley Franklin Coal Co.		X		Ed Shaffer Coal Co.		X	
Cimarron Coal Corp.		X		Sherwood Templeton Coal Co.		X	
Comet Collieries Inc.		X		Skoog & Stuart Coal Co.		X	
Consolidation Coal Co.	X			South Hopkins Coal Co.	X		
Dark Star Coal Inc.		X		Southwestern Illinois Coal Co.		X	
Decola Coal Co.		X		Squaw Creek Coal Co.	X		
Deep Valley Coal Co.		X		Stenftenagle Coal Co.		X	
Dierdorf Coal Co.		X		Stevens and Bennett Cantr. Co.		X	
Dolph Hazlewood Coal Co.		X		Stonefort Mining Corp.		X	
Drakesbro Transp. Co.		X		Sullivan Coal Corp.		X	
Enos Coal Corp.	X			Sunshine Coal Corp.		X	
Florida Coal Co.		X		Tab Mining Co. Inc.		X	
Forsyth Energy Co.	X			Triple S Mines Inc.		X	
Dolph Foster Coal Co.		X		Truax Traer Coal Co.	X		
Fox Bros. Coal Co.		X		S. L. Turner Coal Co.	X		
Freeman Coal Co.	X			United Electric Coal Co.	X		
Gibraltar Coal Co.		X		V-Day Coal Co.	X		
Goldsberry Coal Co.		X		Venedy Coal Co.			Out of business
Green Coal Co.		X		Walker & Son Coal Co.		X	
Harrisburg Coal Co.		X		Walter Richard Mine		X	
Hazel Dell Coal Corp.		X		Walton Coal Co.		X	
Henderson Coal Co.		X		Wardlaw Mining Co.		X	
Houston Coal Co.	X			Webster Caunty Coal Corp.			Gone - no address
Inland Steel Co.	X			Weirs Creek Co.		X	
Island Creek Coal Co.		X		Weiskol Mining Co.	X		
J. & H. Coal Co.		X		West Star Coal Co.			Out of business
Lafayette Coal Co.		X		West & West Coal Co.		X	
Kings Station Coal Co.		X		Williams Creek Coal Inc.		X	
Kirkpatrick Coal Co.	X			Wood Coal Co.		X	
Lemmons and Co.		X		Wright Coal Co.		X	
Log Cabin Coal Co.		X		Ziegler Coal and Cake Co.	X		
Main Line Coal Co.			Out of business				
Maple Grove Coal Co.		X					
Meltons Coal Co.		X					
Moffat Coal Co.		X					
Monterrey Coal Co.		X					
					23	103	

STATE	SFAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS)	IN SFAM	IN STATE WITH 2	TOTAL SULFUR CONTENT	ESTIMATED UNKNOWN	ALL	S2				
		0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP		
ILL	ASSUMPTION	0	0	0	0	0	126	0	0	0	228	354
ILL	RAID HILL	0	0	0	0	0	0	0	0	0	2	2
ILL	BRIAR HILL	0	0	0	0	0	0	0	0	0	6	6
ILL	DAVIS	0	0	0	0	0	0	41	62	313	2634	3050
ILL	DEKOVEN	0	0	0	0	0	45	0	93	105	2017	2260
ILL	FRIENDSVILLE	0	0	0	19	0	0	0	0	0	73	92
ILL	JAMESTOWN	0	0	0	0	0	0	0	0	0	610	610
ILL	LITCHFIELD	0	0	0	0	0	0	0	0	0	2655	2655
ILL	LOWELL	0	0	0	0	0	0	0	0	0	0	0
ILL	MAKANDA	0	0	0	0	0	0	0	0	0	59	59
ILL	MC CLEARYS BLUFF	0	0	0	0	0	0	0	0	0	0	0
ILL	MT RORAH	0	0	0	0	0	0	0	0	0	75	75
ILL	MURPHYSBORO	92	0	0	0	0	0	0	0	228	988	1308
ILL	NEW BURNSIDE	0	0	0	0	0	0	0	0	0	0	0
ILL	O NAN	0	0	0	0	0	0	0	0	0	0	0
ILL	REYNOLDSBURG	0	0	0	0	0	0	0	0	0	69	69
ILL	SEAHORNE	0	0	0	0	0	0	0	0	0	35	35
ILL	SEELYVILLE	0	0	0	0	0	0	0	0	0	3639	3639
ILL	SHAWNEETOWN	0	0	0	0	0	0	0	0	0	33	33
ILL	TROWBRIDGE	0	0	0	0	97	0	0	0	0	94	191
ILL	WILEY	0	0	0	0	0	0	0	0	0	1002	1002
ILL	WILLIS	0	0	0	0	0	0	0	0	3	36	39
ILL	WISE RIDGE	0	0	0	0	0	0	0	0	0	6	6
ILL	1	0	0	0	0	0	0	0	202	1009	1612	2823
ILL	2	105	0	53	3	295	799	172	683	1683	26558	30351
ILL	4	0	0	0	0	0	0	0	156	377	2617	3150
ILL	5	383	0	0	118	1244	554	3382	2657	1491	45422	55251
ILL	6	211	0	1177	1102	794	1963	3450	8590	13220	41924	72434
ILL	7	0	0	0	0	316	383	129	278	119	13132	14357
ILL	8	0	0	0	0	0	0	0	0	0	171	171

Appendix C. Table 1.

C-1.

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS)	IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED										UNKNOWN	ALL S%
			0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP			
IND	ALUF CREEK	3	30	0	0	0	0	0	0	0	88	179	300	
IND	BRAZIL-U	0	0	123	0	0	0	0	0	0	0	407	530	
IND	CANNELTON	0	0	0	0	0	0	35	0	0	0	103	138	
IND	COAL I	42	0	0	0	0	0	0	0	77	10	536	665	
IND	COAL IA	0	1	0	0	0	0	0	0	0	0	73	74	
IND	COAL II	0	0	0	0	0	0	0	0	0	0	496	496	
IND	COAL III	83	0	0	92	0	690	158	0	442	671	4750	6886	
IND	COAL IIIA	0	0	65	26	31	0	0	0	0	124	435	681	
IND	COAL IV	0	445	393	146	84	250	0	5	4894	103	3468	4894	
IND	COAL IVA	66	0	0	0	0	0	0	0	0	156	404	626	
IND	COAL V	279	243	77	576	489	1176	365	517	2398	4654	10774	10774	
IND	COAL VA	0	0	0	0	0	0	0	0	0	0	581	581	
IND	COAL VR	0	0	0	0	0	0	83	89	0	0	881	1053	
IND	COAL VI	93	246	2	237	63	639	406	975	473	4525	7649	7649	
IND	COAL VII	221	267	341	0	123	226	265	401	84	3239	5167	5167	
IND	DALE	0	0	0	0	0	0	0	0	0	0	0	0	
IND	DTINFEY	0	0	0	0	0	0	0	0	0	0	8	8	
IND	FAIRBANKS	100	0	0	145	0	0	0	0	0	0	0	245	
IND	FERDINAND	0	0	0	0	0	0	0	0	0	0	0	0	
IND	HOLLAND	0	0	0	0	0	0	0	0	0	0	168	168	
IND	LOWER BLOCK	192	174	0	77	26	0	0	0	0	211	951	1631	
IND	MANSFELD-U	87	0	21	0	0	0	0	0	0	0	669	777	
IND	MARIAH HILL	0	557	29	49	0	0	0	11	0	0	989	1635	
IND	MC CLEARYS BLUFF	0	0	0	0	0	0	0	0	0	0	0	0	
IND	MINSHALL	71	32	139	6	191	481	99	0	0	204	1862	3075	
IND	PARKER	0	0	0	0	0	0	0	0	0	0	0	0	
IND	SILVERWOOD	0	0	0	62	0	0	0	0	0	0	0	62	
IND	STAUNTON-U	0	0	0	0	101	0	31	0	28	884	1044	1044	
IND	UPPER BLOCK	24	184	63	10	0	0	157	0	166	947	1551	1551	

Appendix C. Table 1. (Continued).

STATE SEAM NAME/NUMBER		TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED										UNKNOWN ALL S%	
		0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP			
WKY	AMOS	0	0	0	0	0	0	0	0	0	24	24	24
WKY	BELTON	0	0	0	0	0	109	0	2	0	0	0	111
WKY	DEANFIELD	0	0	0	0	0	0	11	0	0	35	35	46
WKY	DUNBAR	38	0	0	0	0	136	117	13	0	225	225	529
WKY	FOSTER	0	0	0	2	0	34	0	0	0	9	9	45
WKY	GEIGER LAKE	0	0	0	0	0	0	0	0	0	0	0	0
WKY	HAWESFIELD	0	0	0	0	0	0	0	0	0	0	0	0
WKY	HAWESVILLE	0	0	0	0	1	0	0	0	0	43	43	44
WKY	LEAD CREEK	0	0	0	0	15	0	0	0	49	78	78	142
WKY	LEWISPORT	0	0	0	0	0	0	1	67	33	31	31	132
WKY	LOWER OTTER CREEK	0	0	0	0	0	0	0	0	0	174	174	174
WKY	MAIN NOLIN	53	69	0	0	0	0	0	0	0	42	42	164
WKY	MINING CITY	26	0	0	0	0	0	36	0	0	69	69	131
WKY	POTTSVILLE 2	0	0	0	0	0	0	0	0	0	123	123	123
WKY	SCHULTZTOWN	0	0	0	0	0	0	0	0	0	0	0	0
WKY	SEELYVILLE	0	0	0	0	0	0	0	0	0	14	14	14
WKY	UPPER OTTER CREEK	0	0	0	0	0	0	0	0	0	2	2	2
WKY	WHITE ASH	0	0	0	0	6	0	0	0	0	13	13	19
WKY	18	0	14	0	0	14	15	0	0	0	6	6	49
WKY	10	0	0	0	0	0	0	0	44	0	277	277	321
WKY	11	0	0	0	0	0	0	682	334	973	793	793	2782
WKY	12	134	123	0	0	0	98	613	0	165	390	390	1523
WKY	13	123	4	73	123	96	113	97	0	0	461	461	871
WKY	14	0	33	0	0	0	0	0	81	371	90	90	671
WKY	15	0	0	0	0	0	0	0	0	0	108	108	108
WKY	3	0	0	0	0	0	0	0	0	0	18	18	18
WKY	4	0	145	80	0	0	0	150	0	0	128	128	530
WKY	5	0	0	0	0	0	0	0	0	0	252	252	252
WKY	6	0	0	0	0	0	73	121	0	67	267	267	528
WKY	7	0	0	0	0	0	0	89	0	0	46	46	135
WKY	8	0	0	0	0	0	0	0	0	68	60	60	128
WKY	88	0	0	0	0	0	0	0	0	0	5	5	5
WKY	9	0	0	0	0	0	88	1235	1662	1924	2405	2405	7314

Appendix C. Table 1. (Continued).

C-3.

ILL	LITCHFIELD	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	513	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	2142	UNKNOWN
ILL	LOWELL	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	MAKANDA	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	59	UNKNOWN
ILL	MC CLEARYS BLUFF	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	MT RORAH	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	75	UNKNOWN
ILL	MURPHYSBORO	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	92	0	0	0	0	0	0	85	87	001-149
		0	0	0	0	0	0	0	0	143	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	724	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	177	UNKNOWN
ILL	NEW BURNSIDE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED- WITH FEET									
ILL	O NAN	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	REYNOLDSBURG	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	69
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	SEAHORNE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	35
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	SPELVILLE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	147
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	SHAWNEETOWN	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	TROWBRIDGE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	97	0	0	0	0	UNKNOWN
ILL	WILEY	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	UNKNOWN

STATE SEAM NAME/NUMBER TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED- WITH FEET

ILL	WILLIS	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	3	36	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	WISF RIDGE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	6	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
ILL	1	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	202	695	944	001-149
		0	0	0	0	0	0	0	0	297	254	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	17	414	UNKNOWN
ILL	2	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	53	3	83	111	72	146	1294	5447	001-149
		0	0	0	0	108	0	0	86	117	7265	150-299
		0	0	0	0	104	155	100	261	199	5195	300-499
		0	105	0	0	0	438	0	128	0	1956	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	95	0	62	73	6695	UNKNOWN
ILL	4	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	156	0	173	001-149
		0	0	0	0	0	0	0	0	0	182	150-299
		0	0	0	0	0	0	0	0	0	172	300-499
		0	0	0	0	0	0	0	0	0	518	500-999
		0	0	0	0	0	0	0	0	0	216	1000-UP
		0	0	0	0	0	0	0	0	377	1356	UNKNOWN
ILL	5	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	112	1104	238	97	3801	001-149
		0	0	0	0	524	442	1436	478	841	3826	150-299
		0	0	0	118	449	0	106	781	0	5884	300-499
		0	383	0	0	271	0	736	476	399	10654	500-999
		0	0	0	0	0	0	0	0	0	9875	1000-UP
		0	0	0	0	0	0	0	684	154	11382	UNKNOWN
ILL	6	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		3	0	20	217	58	70	1303	1563	1077	3779	001-149
		0	86	118	353	603	679	791	2855	4376	5231	150-299
		0	4	34	316	48	464	1186	2317	4062	8203	300-499
		0	121	1005	110	85	750	170	1735	3417	15847	500-999
		0	0	0	106	0	0	0	0	0	5326	1000-UP
		0	0	0	0	0	0	0	120	288	3538	UNKNOWN

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED-										WITH FEET
ILL	7	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	250	89	140	0	1479	001-149
		0	0	0	0	316	0	40	138	0	2890	150-299
		0	0	0	0	0	0	0	0	119	3029	300-499
		0	0	0	0	0	0	0	0	0	2248	500-999
		0	0	0	0	0	0	0	0	0	214	1000-UP
		0	0	0	0	0	133	0	0	0	3272	UNKNOWN
ILL	8	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	171	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN

Appendix C. Table 2. (Continued).

C-8.

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS)	IN SEAM	TOTAL SULFUR CONTENT	ESTIMATED- WITH FEET						
IND	BLUE CREEK	0.0-0.9 3	1.0-1.4 30	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 0	4.5-UP 88	UNKNOWN- OVERBURDEN 179 001-149 0 150-299 0 300-499 0 500-999 0 1000-UP 0 UNKNOWN 0
IND	BRAZIL-U	0.0-0.9 0	1.0-1.4 0	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 0	4.5-UP 0	UNKNOWN- OVERBURDEN 308 001-149 0 150-299 0 300-499 0 500-999 0 1000-UP 0 UNKNOWN 99
IND	CANNELTON	0.0-0.9 0	1.0-1.4 0	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 0	4.5-UP 0	UNKNOWN- OVERBURDEN 0 001-149 0 150-299 0 300-499 0 500-999 0 1000-UP 0 UNKNOWN 103
IND	COAL I	0.0-0.9 42	1.0-1.4 0	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 77	4.5-UP 10	UNKNOWN- OVERBURDEN 107 001-149 55 150-299 203 300-499 0 500-999 0 1000-UP 0 UNKNOWN 171
IND	COAL IA	0.0-0.9 0	1.0-1.4 1	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 0	4.5-UP 0	UNKNOWN- OVERBURDEN 32 001-149 41 150-299 0 300-499 0 500-999 0 1000-UP 0 UNKNOWN 0
IND	COAL II	0.0-0.9 0	1.0-1.4 0	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 0	3.5-3.9 0	4.0-4.4 0	4.5-UP 0	UNKNOWN- OVERBURDEN 232 001-149 105 150-299 78 300-499 81 500-999 0 1000-UP 0 UNKNOWN 0
IND	COAL III	0.0-0.9 0	1.0-1.4 0	1.5-1.9 0	2.0-2.4 0	2.5-2.9 0	3.0-3.4 158	3.5-3.9 132	4.0-4.4 301	4.5-UP 2	UNKNOWN- OVERBURDEN 693 001-149 1231 150-299 1900 300-499 313 500-999 208 1000-UP 405 UNKNOWN 32

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS)	IN SEAM	WITH % TOTAL SULFUR	CONTENT ESTIMATED-	WITH FEET						
IND	COAL IIIA	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	26	0	31	0	124	83	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	65	0	0	0	0	0	352	UNKNOWN
IND	COAL IV	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	112	161	51	84	0	88	5	103	1216	001-149
		0	203	50	95	0	0	162	0	0	819	150-299
		0	124	182	0	0	0	0	0	0	847	300-499
		0	0	0	0	0	0	0	0	0	438	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	6	0	0	0	0	0	0	0	148	UNKNOWN
IND	COAL IVA	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	156	0	001-149
		0	0	0	0	0	0	0	0	0	79	150-299
		0	0	0	0	0	0	0	0	0	154	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		66	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	171	UNKNOWN
IND	COAL V	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	122	77	85	0	12	448	471	713	577	001-149
		279	0	0	165	95	196	612	46	1548	667	150-299
		0	121	0	326	394	0	116	0	137	1794	300-499
		0	0	0	0	0	0	0	0	0	1458	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	157	0	0	0	158	UNKNOWN
IND	COAL VA	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	51	001-149
		0	0	0	0	0	0	0	0	0	165	150-299
		0	0	0	0	0	0	0	0	0	168	300-499
		0	0	0	0	0	0	0	0	0	80	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	117	UNKNOWN
IND	COAL VB	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	31	001-149
		0	0	0	0	0	0	0	0	0	39	150-299
		0	0	0	0	0	0	0	0	0	294	300-499
		0	0	0	0	0	0	0	0	0	517	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	83	0	89	0	0	UNKNOWN
IND	COAL VI	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	92	2	237	63	313	502	622	352	759	001-149
		83	154	0	0	0	0	52	353	0	1040	150-299
		0	0	0	0	0	0	0	0	121	1677	300-499
		0	0	0	0	0	93	0	0	0	516	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	85	0	0	533	UNKNOWN

STATE SFAM NAME/NUMBER		TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH 8 TOTAL SULFUR CONTENT ESTIMATED-											WITH FEET	
IND	COAL VII	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		0	109	341	0	123	187	159	280	84	1080	0	001-149	
		0	158	0	0	0	78	67	121	0	954	150-299	150-299	
		142	0	0	0	0	0	0	0	0	476	300-499	300-499	
		0	0	0	0	0	0	0	0	0	130	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		79	0	0	0	0	0	0	0	0	599	UNKNOWN	UNKNOWN	
IND	DALE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		0	0	0	0	0	0	0	0	0	0	0	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		0	0	0	0	0	0	0	0	0	0	UNKNOWN	UNKNOWN	
IND	DITNEY	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		0	0	0	0	0	0	0	0	0	0	0	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		0	0	0	0	0	0	0	0	0	8	UNKNOWN	UNKNOWN	
IND	FAIRBANKS	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		100	0	0	0	0	0	0	0	0	0	0	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		0	0	0	145	0	0	0	0	0	0	UNKNOWN	UNKNOWN	
IND	FERDINAND	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		0	0	0	0	0	0	0	0	0	0	0	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		0	0	0	0	0	0	0	0	0	0	UNKNOWN	UNKNOWN	
IND	HOLLAND	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		0	0	0	0	0	0	0	0	0	0	0	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		0	0	0	0	0	0	0	0	0	168	UNKNOWN	UNKNOWN	
IND	LOWER BLOCK	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	001-149	
		116	135	0	0	26	0	0	0	211	604	0	001-149	
		0	2	0	0	0	0	0	0	0	51	150-299	150-299	
		0	0	0	0	0	0	0	0	0	0	300-499	300-499	
		0	0	0	0	0	0	0	0	0	0	500-999	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	1000-UP	
		76	37	0	77	0	0	0	0	0	296	UNKNOWN	UNKNOWN	

IND	MANSFIELD-U	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		1	0	21	0	0	0	0	0	0	574	001-149
		0	0	0	0	0	0	0	0	0	41	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		86	0	0	0	0	0	0	0	0	54	UNKNOWN
IND	MARIAH HILL	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	410	29	49	0	0	0	11	0	728	001-149
		0	147	0	0	0	0	0	0	0	48	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	213	UNKNOWN
IND	MC CLEARYS BLUFF	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
IND	MINSHALL	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		71	32	139	6	181	99	204	0	204	1125	001-149
		0	0	0	0	0	0	154	0	0	58	150-299
		0	0	0	0	0	0	123	0	0	261	300-499
		0	0	0	0	0	0	0	0	0	19	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	399	UNKNOWN
IND	PARKER	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
IND	SILVERWOOD	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	62	0	0	0	0	0	0	UNKNOWN
IND	STAUNTON-U	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	101	31	0	0	28	695	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	135	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	54	UNKNOWN

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH & TOTAL SULFUR CONTENT ESTIMATED- WITH FEET										
IND	UPPER BLOCK	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		24	46	63	10	0	103	0	0	62	335	001-149
		0	138	0	0	0	0	0	0	0	206	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	169	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	54	0	0	104	237	UNKNOWN

Appendix C. Table 2. (Continued).

C-13.

STATE SEAM NAME/NUMBER TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED- WITH FEET

WKY	AMOS	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	23	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	1	UNKNOWN
WKY	RELTON	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	109	0	2	0	0	UNKNOWN
WKY	DEANFIELD	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	34	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	11	0	0	1	UNKNOWN
WKY	DUNBAR	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	12	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	38	0	0	136	117	13	0	213	UNKNOWN
WKY	FOSTER	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	34	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	9	UNKNOWN
WKY	GEIGER LAKE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
WKY	HAWESFIELD	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN

STATE SEAM NAME/NUMBER		TOTAL COAL RESERVES (MILLIONS OF TONS) IN SFAM IN STATE WITH % TOTAL SULFUR CONTENT ESTIMATED- WITH FEET									
WKY	HAMESVILLE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	1	0	0	0	0	43 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	LEAD CREEK	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	15	0	0	0	49	58 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	LEWISPORT	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	67	33	31 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	LOWER OTTER CREEK	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	114 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	MAIN NOLIN	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	53	69	0	0	0	0	0	9 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	MINING CITY	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	26	0	0	0	36	0	0	0 001-149 150-299 300-499 500-999 1000-UP UNKNOWN
WKY	POTTSVILLE 2	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	0 001-149 150-299 300-499 500-999 1000-UP UNKNOWN

Appendix C. Table 2. (Continued).

WKY	SCHULTZTOWN	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
WKY	SEFLYVILLE	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	14	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
WKY	UPPER OTTER CREEK	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	2	UNKNOWN
WKY	WHITE ASH	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	8	001-149
		0	0	0	0	6	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	5	UNKNOWN
WKY	IP	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	2	001-149
		0	0	0	0	0	0	0	0	0	4	150-299
		0	14	0	0	14	0	0	0	0	0	300-499
		0	0	0	0	0	15	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	0	UNKNOWN
WKY	LO	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	0	0	0	18	001-149
		0	0	0	0	0	0	0	0	0	69	150-299
		0	0	0	0	0	0	0	44	0	148	300-499
		0	0	0	0	0	0	0	0	0	6	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	36	UNKNOWN
WKY	LI	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN
		0	0	0	0	0	0	35	20	472	190	001-149
		0	0	0	0	0	0	466	287	372	175	150-299
		0	0	0	0	0	0	181	27	62	276	300-499
		0	0	0	0	0	0	0	0	0	105	500-999
		0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	67	47	UNKNOWN

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS) IN SEAM IN STATE WITH & TOTAL SULFUR CONTENT ESTIMATED- WITH FEET									
WKY	12	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	76	0	0	98	514	0	134	152 001-149
		0	0	58	123	0	0	91	0	27	140 150-299
		0	0	0	0	0	0	8	0	0	86 300-499
		0	0	0	0	0	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	0	0	4	12 UNKNOWN
WKY	13	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	38	0	0	0	0	0	0	56 001-149
		0	0	85	4	73	0	0	0	0	211 150-299
		0	0	0	0	0	113	0	0	0	63 300-499
		0	0	0	0	0	0	0	0	0	53 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	97	0	0	78 UNKNOWN
WKY	14	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	265	35 001-149
		0	0	0	0	61	0	0	81	54	14 150-299
		0	0	0	0	0	0	0	0	0	37 300-499
		0	0	0	33	35	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	0	0	52	4 UNKNOWN
WKY	15	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	105 001-149
		0	0	0	0	0	0	0	0	0	0 150-299
		0	0	0	0	0	0	0	0	0	0 300-499
		0	0	0	0	0	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	0	0	0	3 UNKNOWN
WKY	3	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	3 001-149
		0	0	0	0	0	0	0	0	0	0 150-299
		0	0	0	0	0	0	0	0	0	0 300-499
		0	0	0	0	0	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	0	0	0	15 UNKNOWN
WKY	4	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	27	0	29	80	0	97	0	0	24 001-149
		0	0	0	116	0	0	12	0	0	90 150-299
		0	0	0	0	0	0	0	0	0	4 300-499
		0	0	0	0	0	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	41	0	0	10 UNKNOWN
WKY	5	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN- OVERBURDEN
		0	0	0	0	0	0	0	0	0	191 001-149
		0	0	0	0	0	0	0	0	0	0 150-299
		0	0	0	0	0	0	0	0	0	0 300-499
		0	0	0	0	0	0	0	0	0	0 500-999
		0	0	0	0	0	0	0	0	0	0 1000-UP
		0	0	0	0	0	0	0	0	0	61 UNKNOWN

STATE	SEAM NAME/NUMBER	TOTAL COAL RESERVES (MILLIONS OF TONS)	IN SEAM	WITH % TOTAL SULFUR	CONTENT ESTIMATED-	WITH FEET							
WV	6	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	
		0	0	0	0	0	0	0	0	40	41	001-149	
		0	0	0	0	0	0	0	0	0	50	150-299	
		0	0	0	0	0	54	0	0	0	77	300-499	
		0	0	0	0	0	0	121	0	0	90	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	
		0	0	0	0	0	19	0	0	27	9	UNKNOWN	
WV	7	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	
		0	0	0	0	0	0	0	0	0	17	001-149	
		0	0	0	0	0	0	0	0	0	0	150-299	
		0	0	0	0	0	0	0	0	0	1	300-499	
		0	0	0	0	0	0	89	0	0	10	500-999	
		0	0	0	0	0	0	0	0	0	0	1000-UP	
		0	0	0	0	0	0	0	0	0	18	UNKNOWN	
WV	8	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	
		0	0	0	0	0	0	0	0	0	68	7	001-149
		0	0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	39	300-499
		0	0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	14	UNKNOWN	
WV	8B	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	
		0	0	0	0	0	0	0	0	0	0	0	001-149
		0	0	0	0	0	0	0	0	0	0	0	150-299
		0	0	0	0	0	0	0	0	0	0	0	300-499
		0	0	0	0	0	0	0	0	0	0	0	500-999
		0	0	0	0	0	0	0	0	0	0	0	1000-UP
		0	0	0	0	0	0	0	0	0	5	UNKNOWN	
WV	9	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN-	OVERBURDEN	
		0	0	0	0	0	36	252	68	1	14	001-149	
		0	0	0	0	0	0	626	766	486	152	150-299	
		0	0	0	0	0	52	233	333	1048	737	300-499	
		0	0	0	0	0	0	124	278	389	1425	500-999	
		0	0	0	0	0	0	0	217	0	63	1000-UP	
		0	0	0	0	0	0	0	0	0	14	UNKNOWN	

Appendix C. Table 2. (Continued).

C-18.

STATE	SEAM THICKNESS	FREQUENCY OF OCCURRENCE	IN STATE OF TOWNSHIPS WITH					CHANNEL CUTOUT AND SEAM THICKNESS					AND % TOTAL SULFUR	
ILL	(INCHES)	0.0-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-UP	UNKNOWN			
	UP TO 24	0	0	0	0	0	0	0	0	0	2			
	25 TO 36	0	0	0	0	0	0	1	0	1	11			
	37 TO 48	0	0	0	1	0	0	1	0	1	12			
	49 TO 60	0	0	0	0	1	0	3	0	0	10			
	61 TO 72	0	0	1	0	2	0	2	4	6	7			
	73 TO 84	0	1	0	0	0	2	0	1	4	6			
	OVER 84	0	1	2	1	0	1	0	0	2	4			
ALL THICKNESSES		0	2	3	2	3	3	7	5	14	52			

Appendix C. Table 2. (Continued).

C-19.

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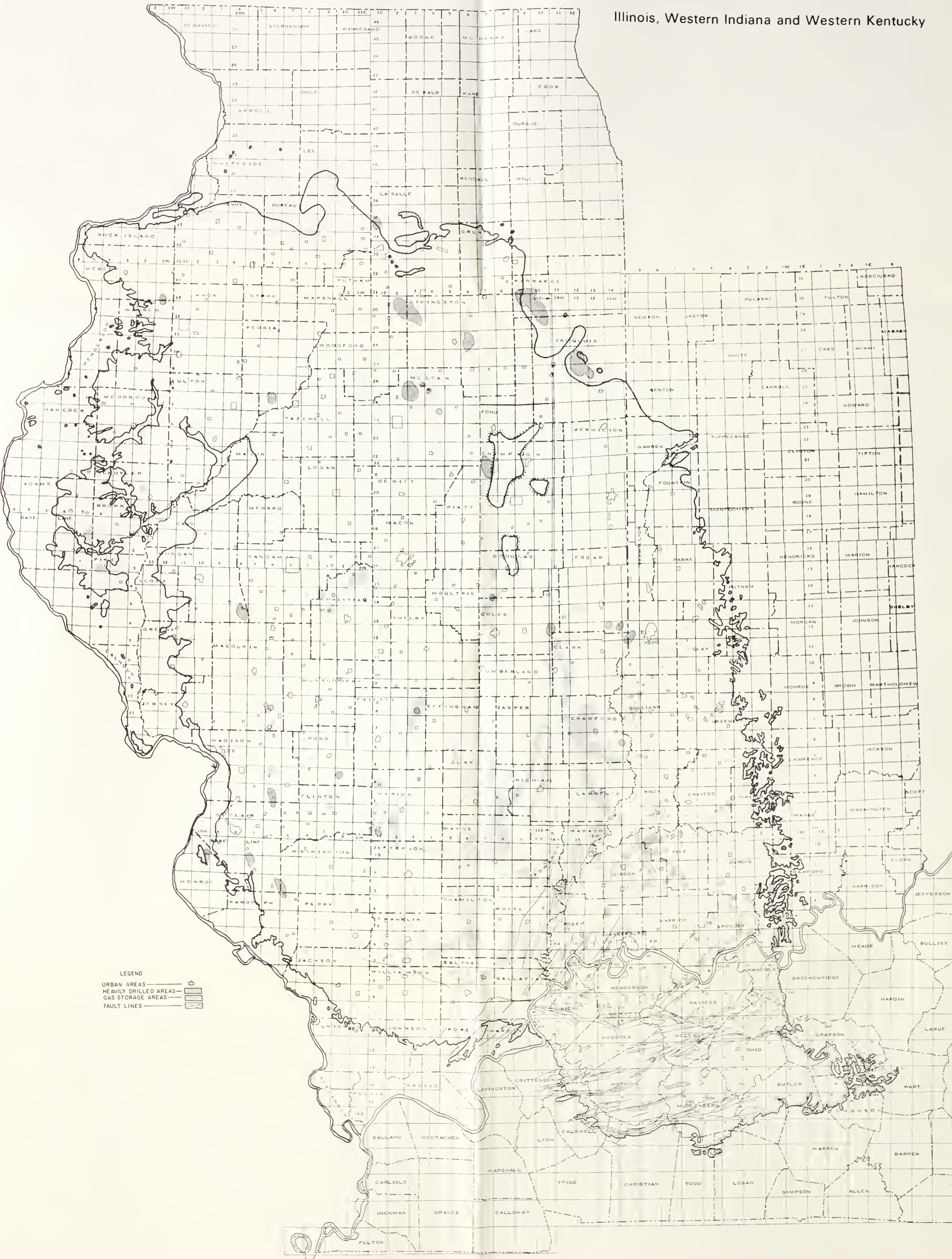
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